# MODERN PLASTICS

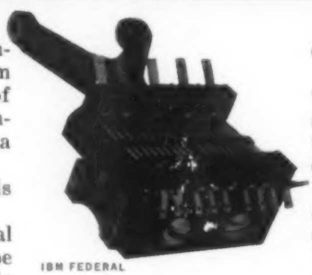
**REVOLUTION IN TRANSPORTATION: The reinforced plastics travel trailer** *p. 92*



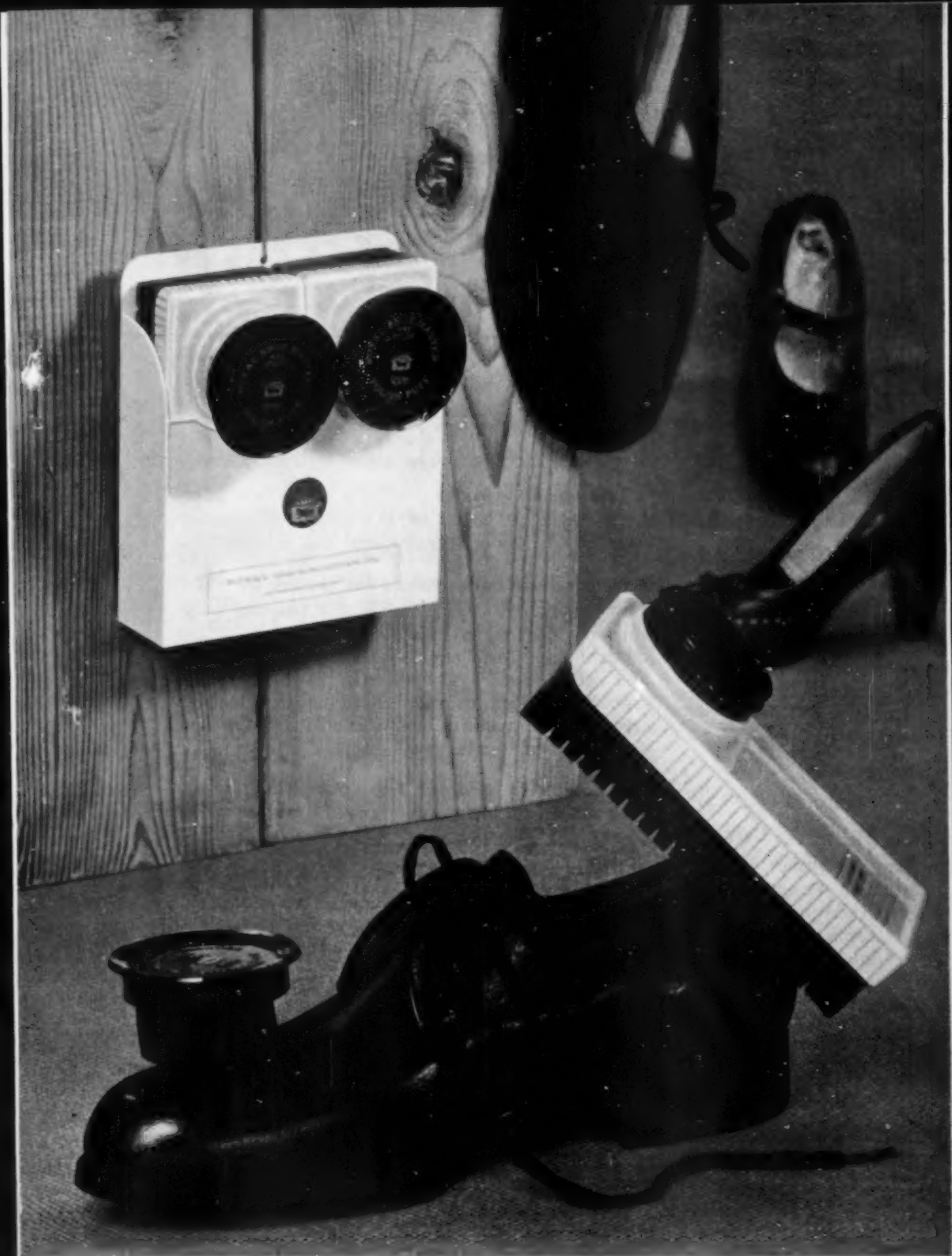
DESIGNED FOR MODERN PLASTICS BY CHARLES W. PELLY


**FEBRUARY 1961**



IBM FEDERAL SYSTEMS DIV.



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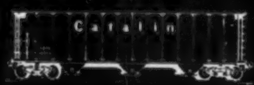
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# MODERN PLASTICS*

**Volume 38, Number 6** **February 1961**


## THE PLASTISCOPE



New polyolefin facilities announced (p. 39); First U. S.-Japanese venture in polypropylene (p. 41); Melamine dinnerware industry reorganizes (p. 43); Another entry to the methacrylate field (p. 45); Latest developments in styrene foam (p. 45); Vinylidene chloride resin now commercial (p. 215).

## EDITORIAL



Resin price peregrinations in vinyls, styrenes, and polyethylenes have drawn attention to the growing profit squeeze at all levels of the plastics industry—and their effect on progressive research and development. Here is what the industry must do to maintain a sound economic posture in a decade that will challenge all of management's skill.

## GENERAL



Out of dire need for corrosion resistance in large and super-strong industrial equipment, and through new resin-reinforcement combinations plus new engineering techniques comes processing equipment of reinforced plastics that has brought startling economies to the user: 40% weight reductions, elimination of maintenance, savings in initial purchase price ranging to over 50 percent. Seven representative case studies of successful applications spell out the picture in detail.



Body of pedal racing car, measuring 55 in. long and 2 ft. high in its deepest section, is blow molded in one piece of high-density polyethylene. Weight of parison is over 14 pounds. Implications of this development for the production of large containers are clear—carboys in the 70- to 90-gal. capacity range are in the offing.



If your productions can benefit from the vividness of fluorescent pigments, the improved light stability and heat resistance of currently produced formulations now makes their use practical. A tipped-on fluorescent polyethylene sheet shows how effective these colorings can be. Full how-to information is given, including formulations and cost factors.



New techniques and adhesives for bonding polyethylene foam makes this material suitable for use in trampoline installations. This is one of the first uses of PE foam in an application of this type and suggests extension to other cushioning fields where severe abuse requires a material that combines resiliency and toughness.



This month's cover story is concerned with a company which, though completely unacquainted with reinforced plastics, was able to obtain in just six months a complete set of molds for the production of the first home trailer with an all-reinforced plastics body. Development of this trailer presages a major breakthrough of reinforced plastics in the transportation field.



The appearance of several small electrical appliances housed in molded nylon cases has made the industry take another look at the suitability of polyamides for housing materials. In the products concerned, nylon was chosen to replace aluminum, melamine, and steel and in each case brought production economies and product improvement. Here are the factors that led to the specification of nylon material in each case.



With a process somewhat resembling the foil decorating technique for thermosets, you can now decorate thermoplastics by using a properly designed laminate at the bottom of a mold. Items so produced require no further decorating operations. Initial application of the process is in eyeglass frames and cosmetic containers. The economics of the method make extension into other product areas likely.



Molded polyester "buttons," incorporating reflective glass beads and bonded to road with epoxy resin, may bring solution to long-standing highway safety problems . . without pain to taxpayers. Plastic traffic markers have had many false starts. This looks like the real thing.

## ENGINEERING



## TECHNICAL



## DEPARTMENTS



### Coming Up . . .

*Polyethylene coating on paper is assuming increasing importance in a number of industries—Our March issue will bring us up to date on the available formulations, their economics, how they are applied and what they can do . . . Latest developments in plastics for lenses . . . A new urethane elastomer processable on plastic injection, extrusion, and transfer-molding equipment . . . Full story of the "Princess telephone" — materials, processing, markets . . . March Engineering Section will lead off with some basic engineering principles for extrusion blow molding, including die, head, and mold design . . . How to design for vacuum metallizing . . . Technical Section will carry an analysis of the infra-red spectrum of polyethylene . . . Also in the works: plastics in signs and displays . . . new ABS polymers and where they are going . . . urethane insulation for gas refrigerators.*

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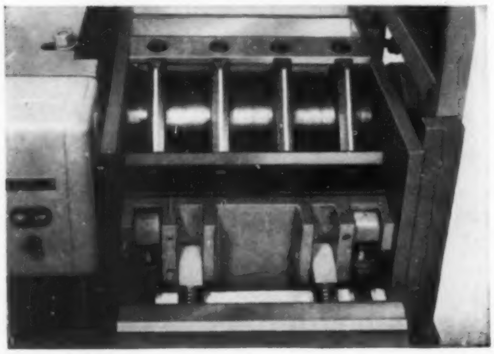
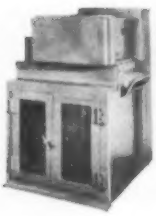
# FIVE NEW Cumberland Large Throat GRANULATING MACHINES

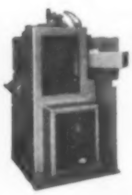


**PART OF THE COMPLETE LINE OF CUMBERLAND PELLETIZERS, BESIDE THE PRESS AND CENTRAL GRANULATING MACHINES, DICERS, CHOPPERS AND PRE-BREAKERS**



**CUMBERLAND PELLETIZING MACHINE**

New feed roll mechanism provides better control of extruded strands of plastic materials. Cuts cubes or pellets 1/32" to 1/2". 14" and 24" openings.



**STAIR STEP DICER**

Produces perfect cubes or pellets 1/16" to 1". Two standard sizes accommodate up to 7" and up to 14" ribbons.

**LARGE THROAT OPENINGS** – 12" x 16" (Shown above). Also 7" x 10", 8½" x 12", 8½" x 16", 12" x 20".

**QUALITY CONSTRUCTED** entirely of steel weldments. Advanced design leaves all working parts readily accessible for cleaning and adjustment of knives.

**NEW PERFORMANCE** – New knife design and slow rotor rpm provide better granulation and quiet operation. Clean cutting of the complete range of thermoplastic materials from softest polyethylene and vinyls to hard and tough nylon, Cycolac, and Kralastic.

**MINIMUM FLOOR AREA** – Desirably compact for central and beside the press applications.

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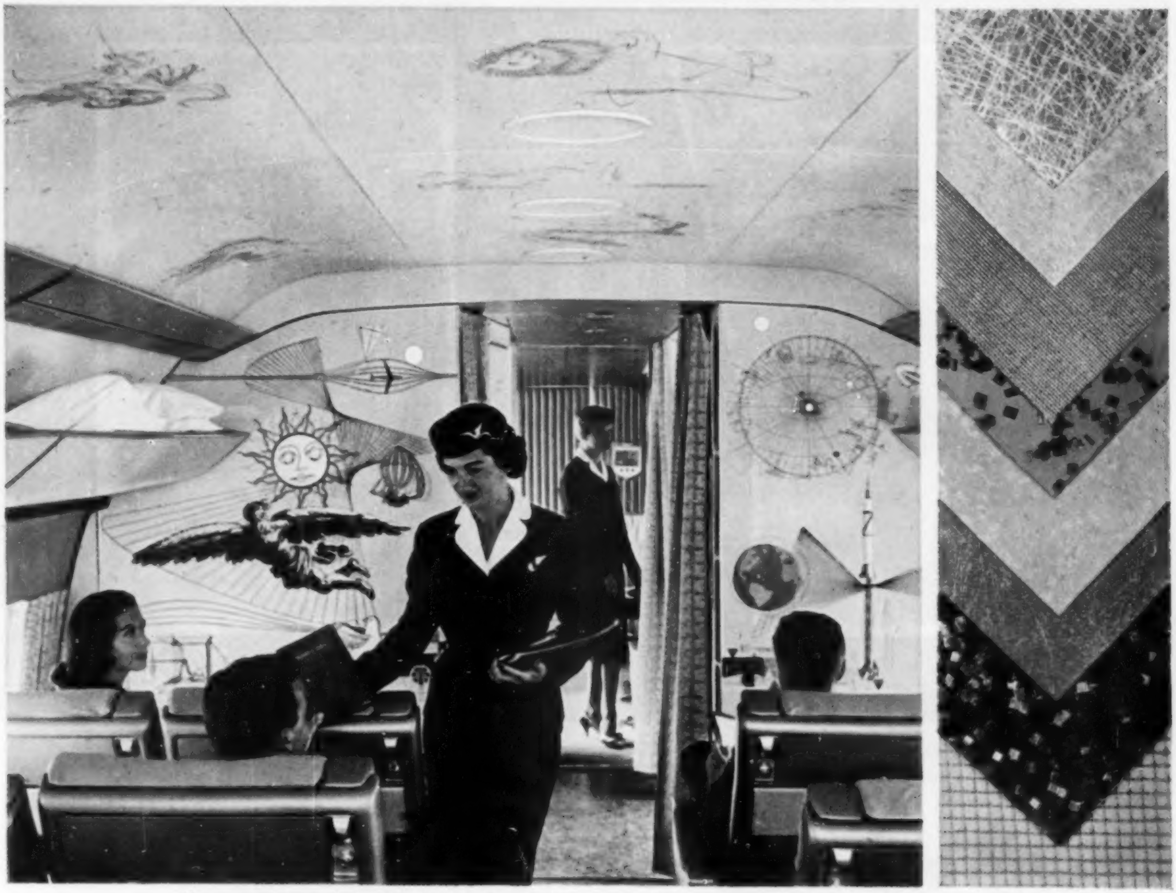

*These panels were designed by Harley Earl for Eastern Air Lines and manufactured by Polyplastex United, Inc., Union, N.J. Other Polyplastex designs are in use on nearly every air line. Panels can be produced to specification, including color or design such as the cabin end murals shown here. B.F.Goodrich Chemical Company supplies the Geon vinyl from which this sheet is made.*

## Geon gives jets their look of luxury

The striking appearance of these jetliner interiors has a practical touch. Surfaces of bulkheads, luggage racks, sidewalls and doors are laminated sheets made from Geon vinyl to produce these unusual designs and brilliant colors. Other laminations made from Geon vinyl decorate walls and cover floors of galley and lavatory areas.

Normally, interior decoration of airplanes requires fairly frequent replacement. After 5 years, interiors like these have yet to call for more than the usual, simple maintenance. Because they're made of tough, durable Geon, these panels can be washed easily, will resist dirt and acids, and don't even show the scratches or "rub wear" that impairs appearance of other materials previously tried.

Here's another example of the way Geon improves products—and sometimes opens whole new markets. For more information, write Dept. NF-2, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

Geon VINYLS

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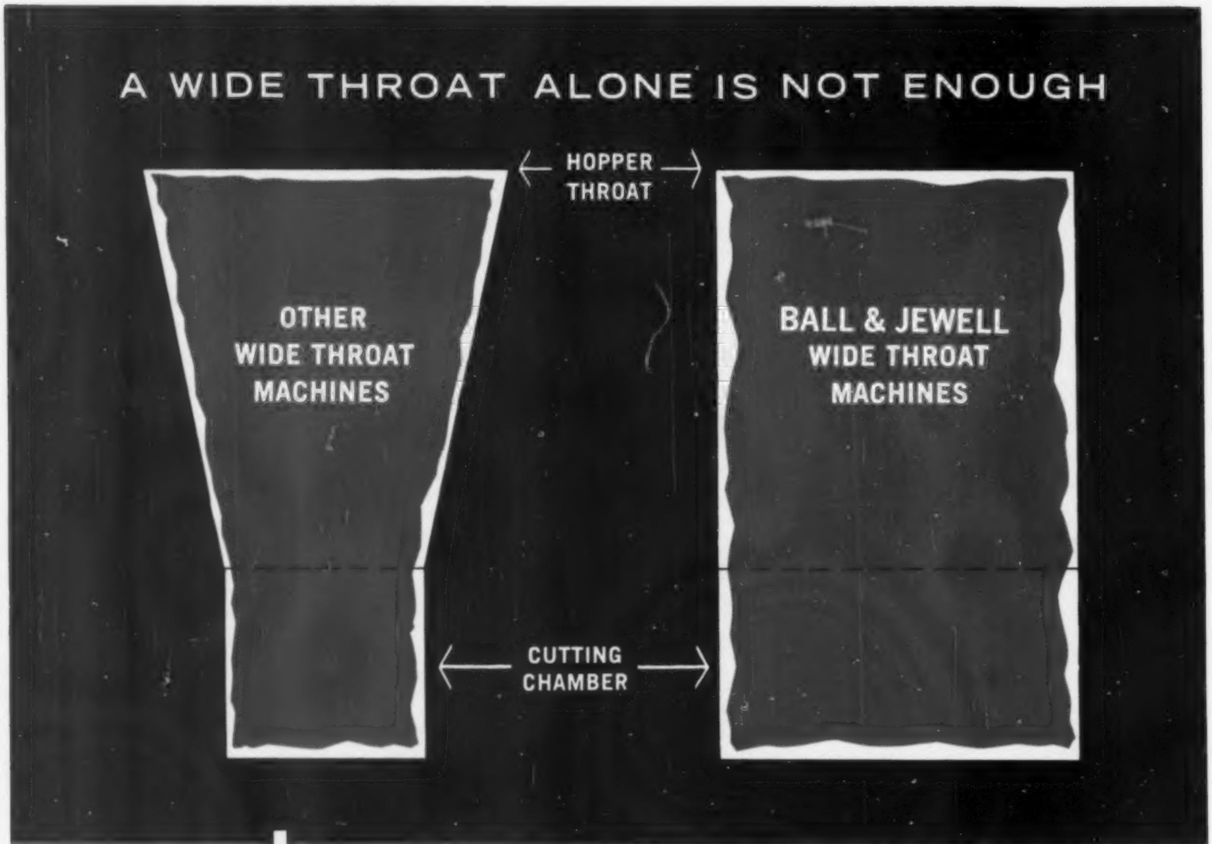
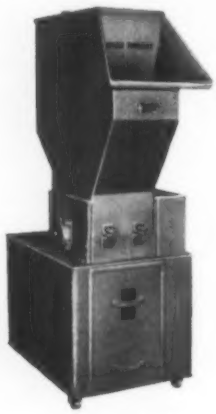



*that's why b&j Marvel Series Wide Throat Granulators have*

# WIDE CUTTING CHAMBERS, TOO!



Some "so-called" wide throat machines are merely adaptations of standard machines—the throat size is increased but the cutting chamber remains unchanged. Not so on B & J Wide Throat Granulators, though.

B & J Marvel Series Wide Throat Granulators not only have wide throats, but also wide cutting chambers. They handle big and odd shaped rejects and all types of bulky scrap with ease. They're ideal for all types of blow molding scrap. Because they're built to do the job right, B & J Marvel Series Wide Throat Granulators outperform all others.

And, although B & J Wide Throat Granulators have all the easy-to-operate, easy-to-maintain features of Marvel Series Granulators, they're priced in line with machines that offer much less. Prove it yourself. Ask for literature and prices.

## 3 MODELS TO CHOOSE FROM

| SPECIFICATIONS | M-200WT | M-300WT | M-400WT |
|---|---|---|---|
| Capacity | 300-400 lbs./hr. | 400-500 lbs./hr. | 500-600 lbs./hr. |
| Floor Area | 25" x 32" | 31" x 37" | 35" x 36" |
| Throat Size | 12" x 12" | 12" x 16" | 12" x 20" |
| Hopper Tray Height | 55" | 55" | 57" |
| Motor | 5—10 H.P. | 10—15 H.P. | 15—20 H.P. |

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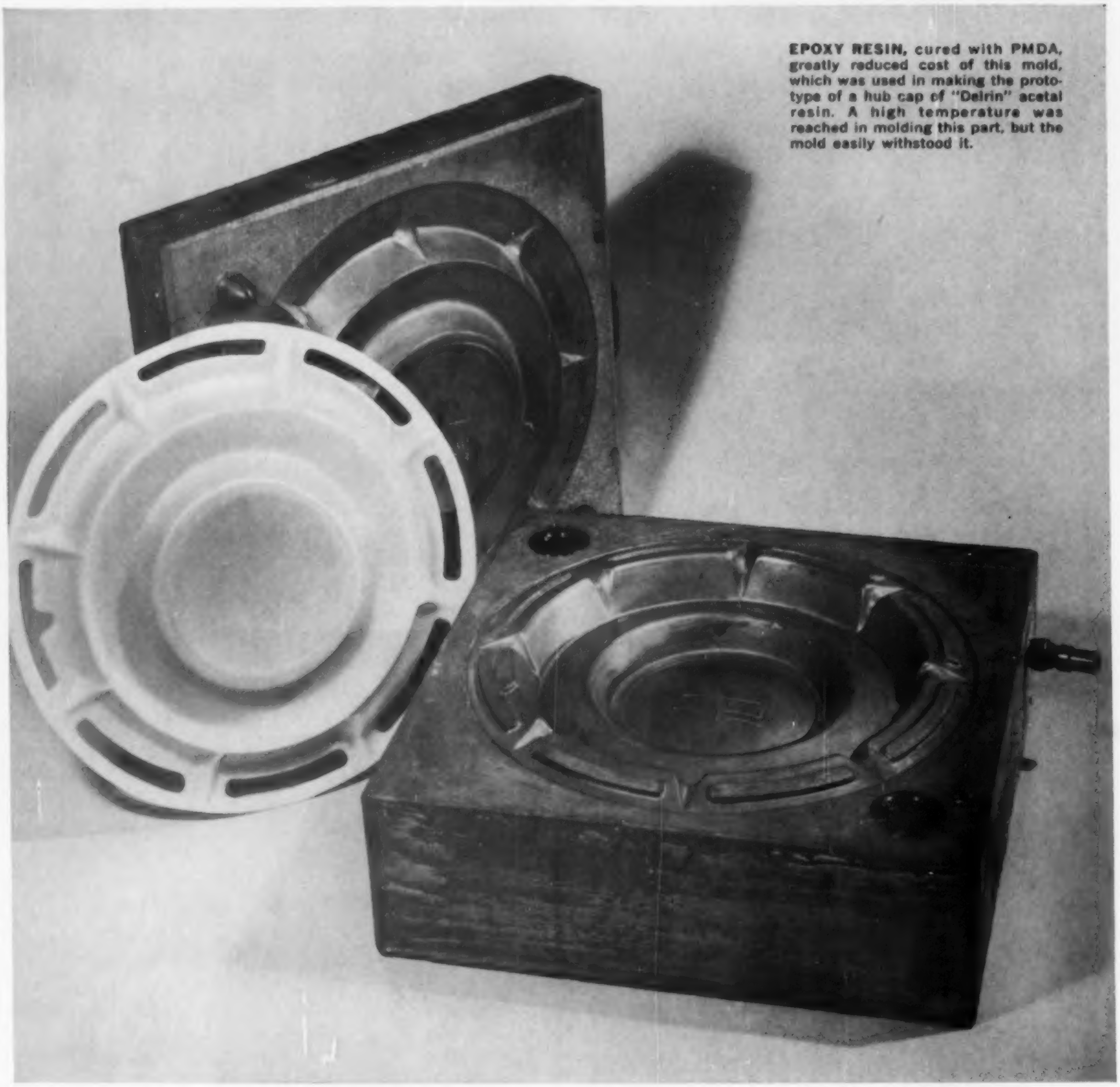

EPOXY RESIN, cured with PMDA, greatly reduced cost of this mold, which was used in making the prototype of a hub cap of "Delrin" acetal resin. A high temperature was reached in molding this part, but the mold easily withstood it.

# $10,500 MOLD FOR PROTOTYPE PARTS NOW COSTS LESS THAN $1,300

Thanks to a new high-temperature epoxy formulation based on Du Pont PMDA hardener, now you can make prototype parts in epoxy resin molds that cost only a fraction of what you would pay for metal molds.

Above, for example, is a mold that cost a little under $1,300 to make. Its counterpart, machined in steel, was estimated to cost $10,500.

In fabricating a wheel disc of Delrin® acetal resin, temperatures went as high as 350°F. inside this mold, yet the epoxy resin had all the heat resistance and strength needed to do the job.

It gets this strength from its curing agent, Du Pont pyromellitic dianhydride. PMDA pushes the heat distortion temperature of an epoxy up past 500°F., adds other chemical and physical advantages as well.

**Save pattern costs.** Another way you can save with a PMDA/epoxy mold is in pattern costs. You can use any model you want, to start with—even wood or plaster of Paris. To make the mold, you simply lay up the epoxy around the model, working at harmless, moderate temperatures.

If you would like to lower the cost of prototype or limited production work, please write us for details. Du Pont, Explosives Department, 6539 Nemours Building, Wilmington 98, Delaware.

DU PONT PMDA

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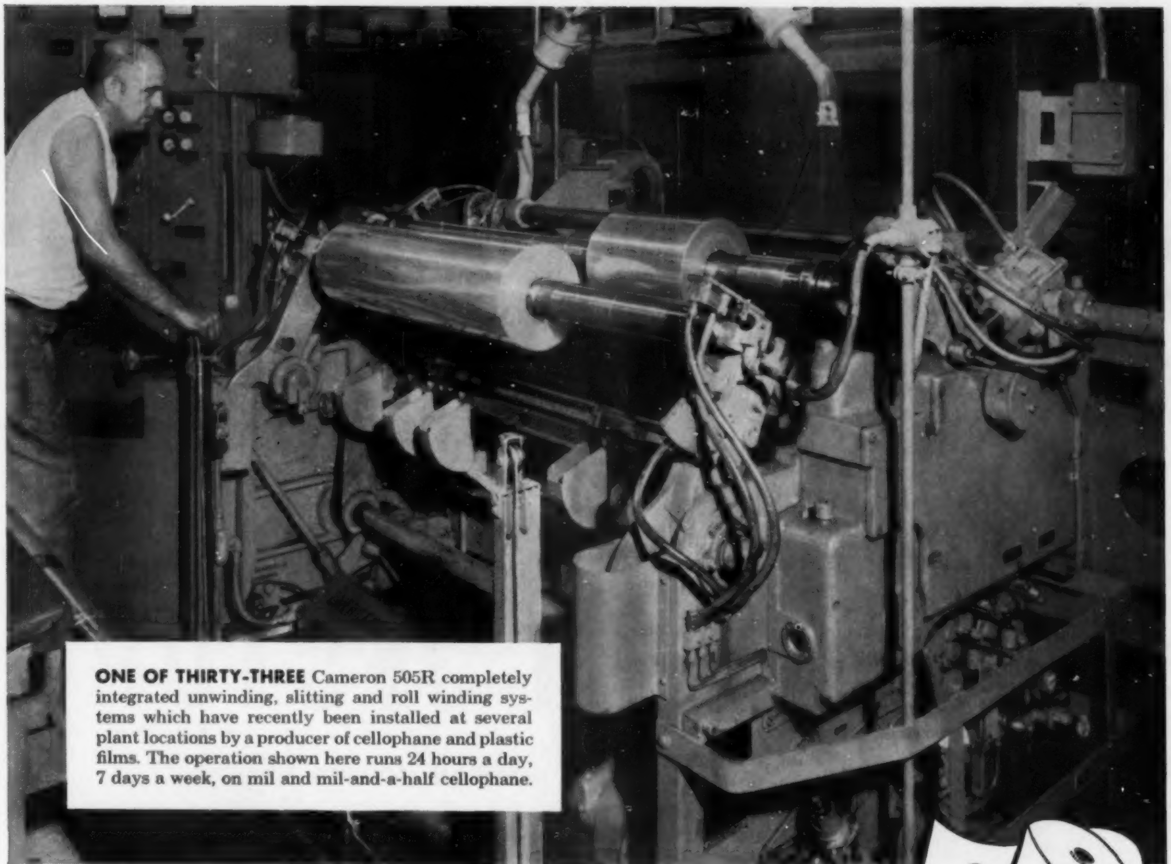

**ONE OF THIRTY-THREE** Cameron 505R completely integrated unwinding, slitting and roll winding systems which have recently been installed at several plant locations by a producer of cellophane and plastic films. The operation shown here runs 24 hours a day, 7 days a week, on mil and mil-and-a-half cellophane.

# *What makes* The New Roll *run so fast?*

**Printers and converters** who have used *The New Roll* in papers, films, foils and laminates ask: How can it run so fast without web breaks? Why does it feed out so smoothly right down to the core? How does it keep the web so "live" for better end results, rather than stretched out "dead" in the roll?

The answer is in the way *The New Roll* is made. We call it *The New Roll* because it is fundamentally different—the product of *truly integrated roll control.*

For example, in the patented Cameron 505R unwinding, slitting and roll winding system (shown above) integrated roll control starts with the Cameron Model LHDSM automatic centering, shaftless unwind, equipped with a skew adjustment, edge guide, and a Cameron Model LHD disc-type, continuous duty unwind brake. The brake responds to signals from an extremely sensitive, air-operated tension sensing system which employs a mill roll follower (reacting to mill roll *payoff*) and a dancer roll (reacting to web *pull*).

Web pull is established by the automatically accelerated, variable speed main drive. Integrated roll control is further maintained by the use of two individually driven, automatically counterbalanced rewind shafts. Speed of the main drive controls the speed of the separate rewind drives. Added control of rewind drive speed is automatically actuated by increasing rewind roll diameter.

Oscillating razor type slitting elements assure cleanly cut, burnished strip edges. Combination surface and center winding is employed to wind the strip in alternate positions on the two rewind shafts. The differential winding principle is applied to permit each roll to adjust its winding speed to variations in diameter due to inconsistencies in caliper across the web. Thus, truly integrated roll control is maintained all the way from unwind to rewind. The result is a finished roll of superb new quality—*The New Roll.*

***Why not let us test-run your material on an integrated, job-fitted "pilot" winding system at our Research and Development Service, in Dover, N. J.? Write for information.***

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**PLASTIC INJECTION MOLDING MACHINE**

## Molding Capacity 2 Oz.

It's your ideal answer to profitable, automatic plastic injection molding of items up to 2 oz.

The new "Imperial" MINI-JECTOR is designed and engineered for fast, low-cost production. It has horizontal clamping, with hydraulic toggle providing approximately 42 tons pressure. Cost is only $6,380 complete.

**Important features include:**

• Rapid cylinder removal and change • Built-in packing stroke—single • Rapid mold removal and change • 2-zone cylinder heat control • Platens drilled for all 9" x 8" tooling • Fast cycling with complete automation • Compensating feed • Adjustable clamp stroke

**Optional features:**

Nylon nozzles • Water-cooled plunger • Weight feeder • Mold chilling and heating systems • Special length nozzles for hot runners molding • Adjustable plunger speed • Adjustable clamp speed

**SPECIFICATIONS**

*Capacity* . . . 2 oz./shot Styrene—1¼ plunger
1½ oz./shot Nylon—1$\frac{1}{16}$ plunger
*Plunger* . . . 1¼ diameter—1$\frac{1}{16}$ diameter
*Pressure* . . . 1¼ diameter 12,800 psi @ 1250 psi line pressure
1$\frac{1}{16}$ diameter 17,800 psi @ 1250 psi line pressure
*Dry Cycle Time—Min.* . . . 5 sec. without packing stroke
7 sec. with packing stroke
*Hydraulic System* . . . Vickers J.I.C. 30 gal. Package Unit—11 gal./min. 5 HP—1200 RPM—3 phase motor
*Clamping System* . . . Hydraulic Toggle—42 tons
*Mold Stroke* . . . 6⅜" maximum
*Mold Size* . . . 9⅞" x 8" Std.—11" x 8" Max. thickness
*Casting Area* . . . 20 in.$^2$ maximum
*Daylight* . . . 8½ closed max.—14⅛ open max.
*Ram Speed* . . . 3½"/sec. or 17½ ft./min.
*Nozzle Discharge Rate* . . . 4.3 cubic inches/sec. or 2.3 oz. Styrene/sec.
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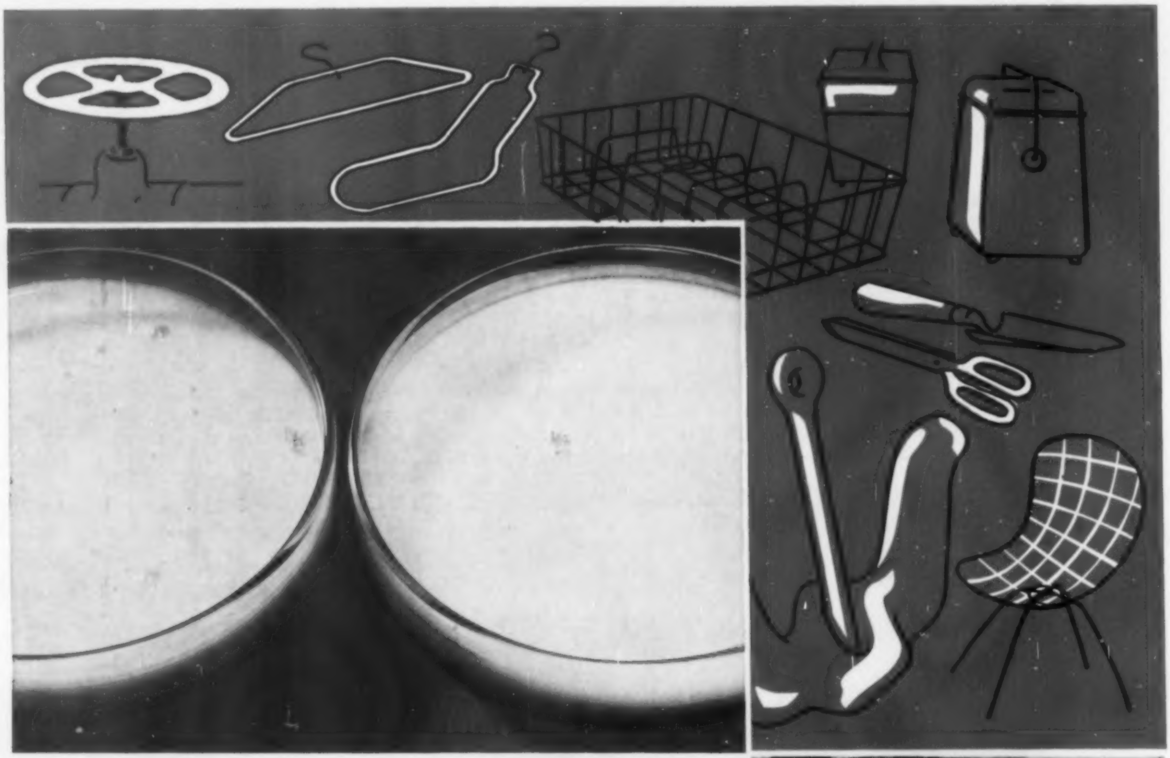
**SILICONE NEWS from Dow Corning**

# Shortcut to Plastisol Profits



## Silicones Speed Deaeration, Improve Scuff Resistance

Reducing production costs is one way to protect profits. Improving your products' performance is another. If you formulate plastisol coating solutions, Dow Corning Silicones will help you both ways. Here's how.

***End production bottlenecks.*** As demonstrated above, the addition of a silicone antifoamer to plastisol formulations speeds deaeration. Both dishes were filled at the same time with the same plastisol solution, but a silicone antifoamer was added to the solution before it was poured in the dish at right. Silicones prevent bubbles, eliminate costly bottlenecks.

***Improve product performance.*** Silicone additives cause plastisols to flow faster and more evenly. This makes it easier for fabricators to produce continuous coatings that are free of pinholes and weak spots; to obtain sharper detail in moldings and castings.

Including Dow Corning Silicones in your plastisol formulas produces important end-product advantages, too. For example, silicones give added "slip" to such products as overshoes, furniture coverings, and bushings — and that means greater resistance to marring, scuffing, and tearing. Another silicone benefit: a more lifelike feel for toys and dolls . . . a softer, more comfortable feel for gloves and rainwear.

***An important activity*** at Dow Corning is research and development in silicone chemistry. That's why Dow Corning continues to be your best source for technical information about the use of silicones in plastisols . . . for the new and improved silicone materials that help you shortcut the way to profits.

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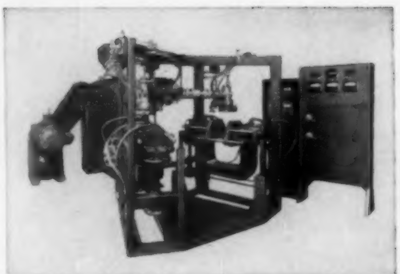
Moreover, many extruders today are "patch-quilt" affairs: one piece made by this company, a second part by that, a third by still another. Not with MPM. For MPM manufactures virtually all its own components: grinds its own screws, assembles its own controls . . . all precision-built to MPM standards in MPM's modern, 90,000 sq. ft. plant.

Screw diameters available range from 1 to 12", in vented or non-vented design, and in L/D ratios of 20:1, 24:1 or longer Either resistance-band heaters, cast-in heaters or induction heating can be specified. Extra heavy-duty thrust bearings, Xaloy-lined barrels, and precision-ground screws are typical of rugged MPM components. In short, MPM extruders are tailored for your specific needs, then proved out to you before you buy. More information? Just write Modern Plastic Machinery Corporation, 64 Lakeview Avenue, Clifton, N. J.



**INTERESTED IN BLOW MOLDING?** Then you'll be interested in the new MPM "Diversamatic." Molds from polyethylene, polypropylene, high-impact styrene, acetate, nylon, other materials. Handles molds up to 36" long, 21" wide, 28" daylight. 14" stroke. Automatic built-in electric counters. All-pneumatic system. Works with any extruder, either U.S. or foreign-built.

mpm **Modern Plastic Machinery Corporation**

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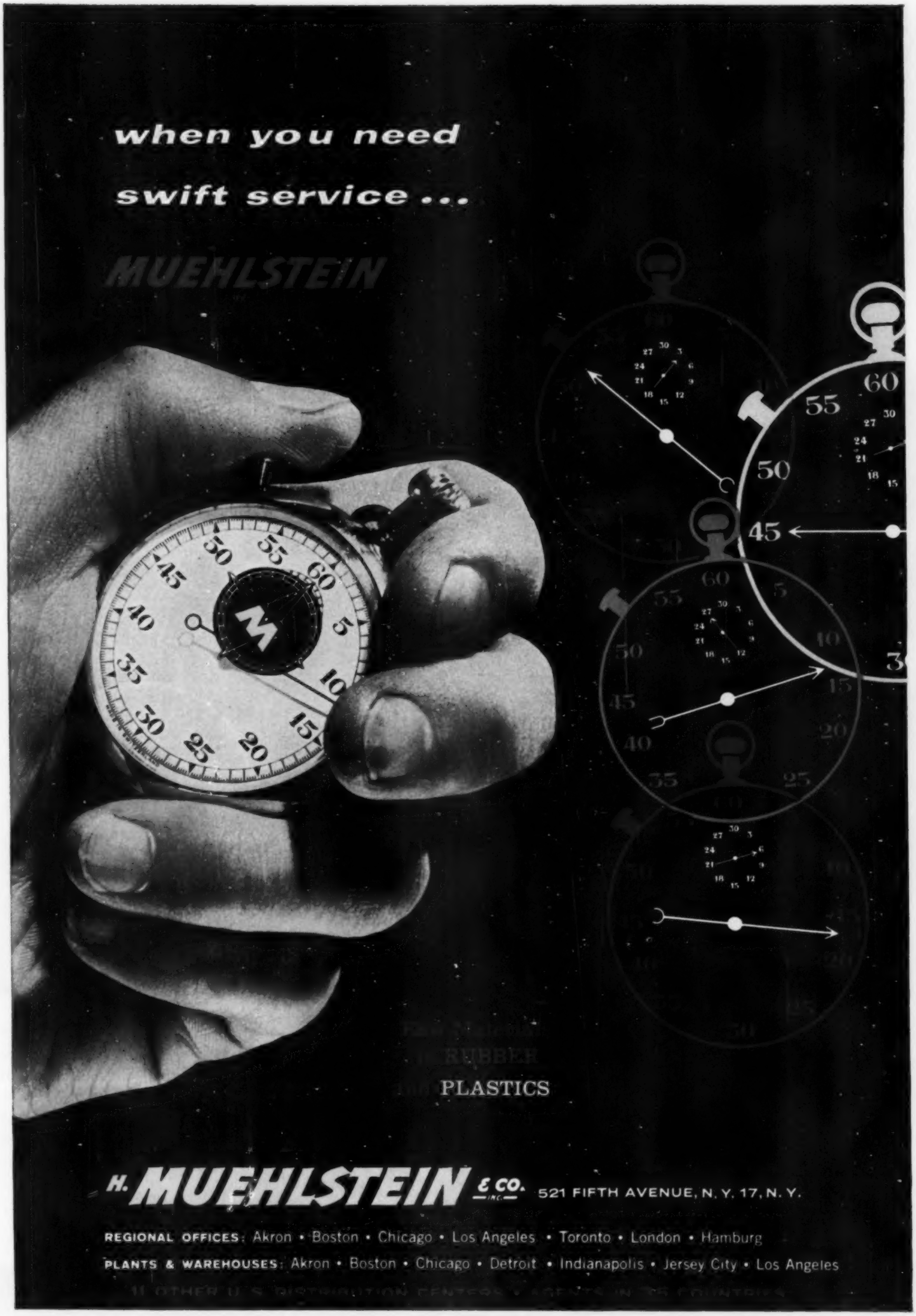
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This Delrin part was proved commercially successful on H-P-M preplasticizing machines in 1959. As with all new materials, molding techniques best suited to its application in industry were carefully analyzed and machine operating features developed for maximum efficiency.

**The use of plastics for automotive parts** has shown a tremendous growth during the past five years. We are actually on the threshold of an even greater breakthrough period. The new plastics, with functional as well as decorative benefits, permit the designer greater latitude in applying the cost reduction advantages of plastic materials for better performance, improved appearance and lower cost. Better machines to mold these new materials also have played an important part in their rapid acceptance. H-P-M preplasticizing principles have opened new possibilities with materials that have posed certain restrictions until recently. New H-P-M machine processes will assure the success of new plastic materials just as surely as new light weight plastics will earn a steadily increasing place in tomorrow's automotive production.

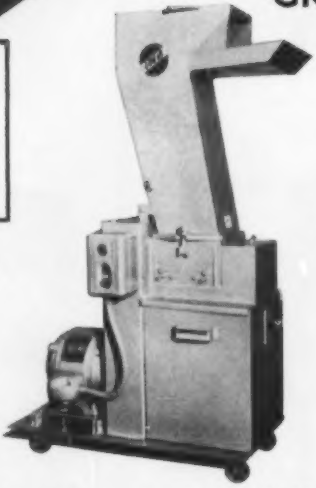
**PLANNING TO MOLD THE TOUGH AUTOMOTIVE JOBS?**

# INJECTION MOLDERS!

# BOOST PRODUCTION!

## M-3 IMS M-4
## GRANULATORS

All machines illustrated here in stock for
**IMMEDIATE SHIPMENT**



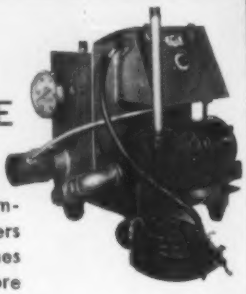
The IMS M-3 6½" x 7" throat sprue grinder — rugged — simple in design—easiest to clean — built-in throat clearance bar — casters — catch pan.

**PRICE: Complete with 1 HP Motor and Starter --- $628.50**
**Same, but with 2 HP Motor ------- $678.00**

The IMS M-4 5⅜" x 8½" throat grinder — designed primarily for vinyl, polyethylene, plastisols and all elastomerics where a fine-free low bulk factor product is desired — large throat for large injection molded parts.

**PRICE: Complete with 2 HP Motor and Starter $815.00**
**Same, but with 3 HP Motor $878.00**

## LOW COST "MIDGET" TEMPERATURE REGULATOR



Duplicates performance of mold heaters costing up to 6 times as much . . . new more compact model with closed circuit ends mold rust . . . cuts your water bills! Temperature range 50° to 250°. . . Portable, only 15" x 22½" floor space.

**PRICE: Complete ------$391.50**

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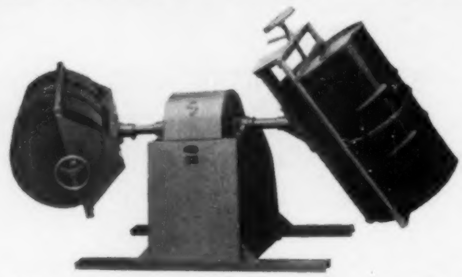

**¾ HP Model ---------------------- $675.00**
(Takes drums up to 33" high x 22" in diam.)
**1 HP Model --------(same as above)-------- $788.50**
**2 HP Model ---------------------- $927.50**
(Takes drums up to 37" high x 23¼" in diam.)
**3 HP Model ---------------------- $1285.00**
(Takes drums up to 43" high x 24" in diam.)
**5 HP Model ---------------------- $2650.00**
(Takes drums up to 45" high x 24" in diam.)

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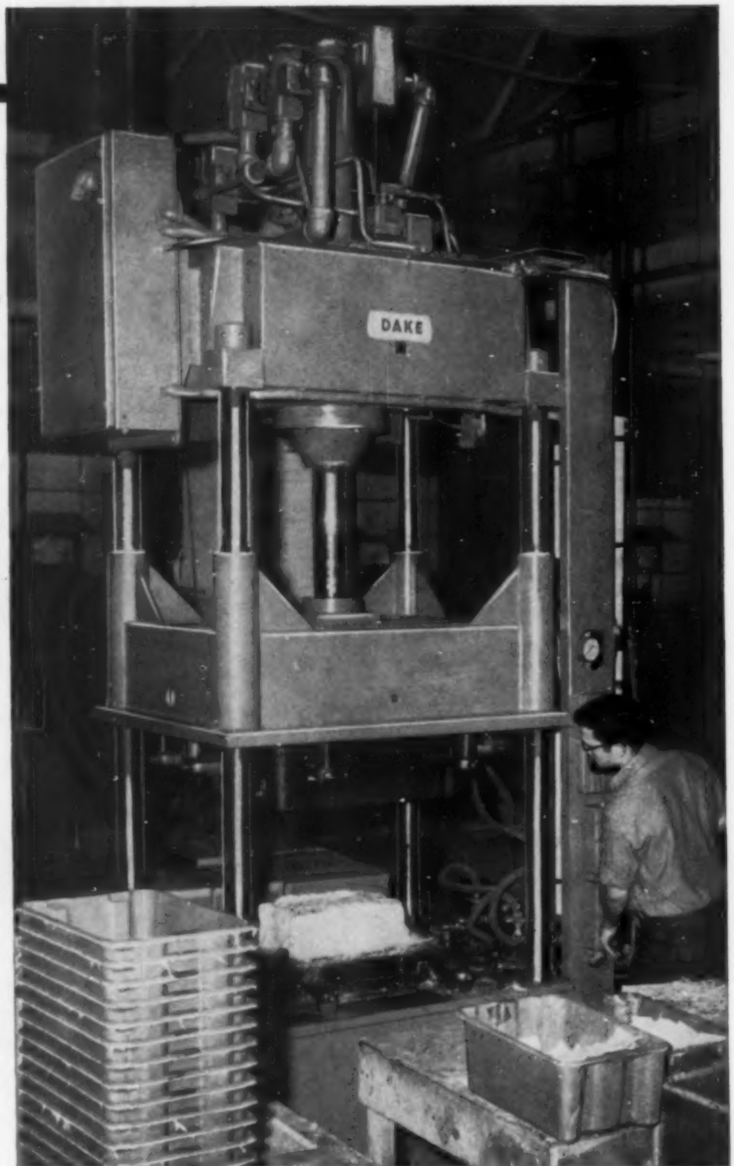


75-Ton Dake Guided Platen Plastic Molding Press forming Stack-n-Nest tote pans at G. B. Lewis Company, Watertown, Wisconsin.

Dake Guided Platen Presses are the latest development in the reinforced plastic molding field. They are job engineered to help you meet all molding requirements, as well as speed production output, and reduce operating costs. Their all-steel construction with long tie rod bearings and larger diameter tie rods provide maximum rigidity to assure extremely accurate work with all types of plastic forms. Standard models are electric-hydraulic in operation and available in capacities from 25 tons to 600 tons. Write for Bulletin 405.

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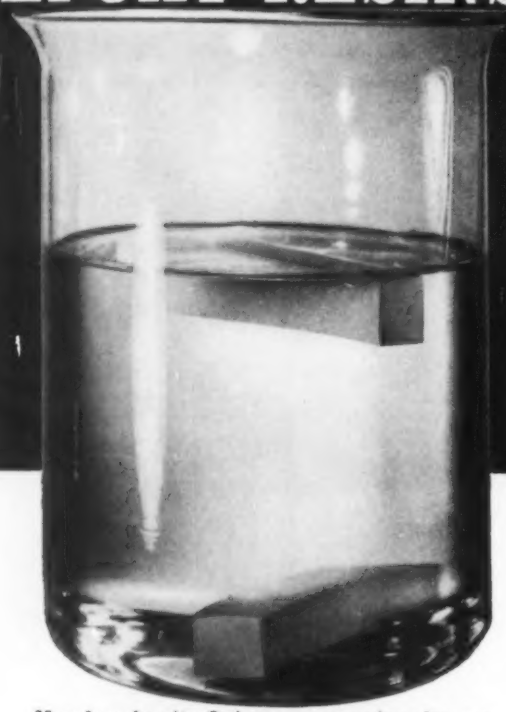
# NEW OXIRONS WEIGH LESS, GO FURTHER THAN CONVENTIONAL EPOXY RESINS



◀ OXIRON BAR FLOATS, CONVENTIONAL EPOXY SINKS IN ORGANIC LIQUID

New low density Oxiron epoxy resins give you structural components with **high strength-to-weight** ratios. They **keep weight to a minimum** in critical applications such as encapsulated electronic assemblies for aircraft and missiles. Oxirons give you the **most coverage** area from every pound of epoxy in your coating formulations. With Oxiron epoxy resins you can accomplish all these things, because the hardened resins have **10 to 20% lower density** than conventional epoxies! And thanks to the extra quantity of product obtainable from each pound of Oxiron epoxy, an **economic gain** is often possible. Where weight must be kept down, Oxirons may well be the answer for applications such as missile and aircraft parts, molds, tools and fixtures, radome panels, transformers and motors, potted electronic components, printed circuits, as well as for general structural laminate use.

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Oxirons are epoxidized polyolefins. Unlike conventional epoxies, Oxirons can be cured through reactive double bonds as well as multiple epoxy groups present in the chain.

### MORE ADVANTAGES

OXIRONS exhibit low shrinkage on cure.

OXIRONS can be cured at relatively low temperatures.

OXIRONS can often be cured with low cost reagents.

OXIRONS provide superior resistance to creep at elevated temperatures.

OXIRONS can be cured with anhydride-peroxides to give materials characterized by heat distortion curves that do not break sharply with temperature.

OXIRONS have excellent electrical properties and stability at high temperatures.

OXIRONS offer high strength, powerful adhesion, good wetting-out properties.

OXIRONS have excellent chemical resistance—are unaffected by strong alkalis, acids, solvents.

*Send for our Epoxy Data Booklet which describes Oxiron 2000, 2001, and 2002 in detail, contains curing information and gives suggested uses. If you'd like a sample, let us know what application you have in mind so that we can supply a suitable resin.*

*Putting Ideas to Work*

FOOD MACHINERY AND CHEMICAL CORPORATION
**Epoxy Department**
161 East 42nd Street, New York 17, N. Y.

**EPOXIDES CURRENTLY AVAILABLE FROM FMC**
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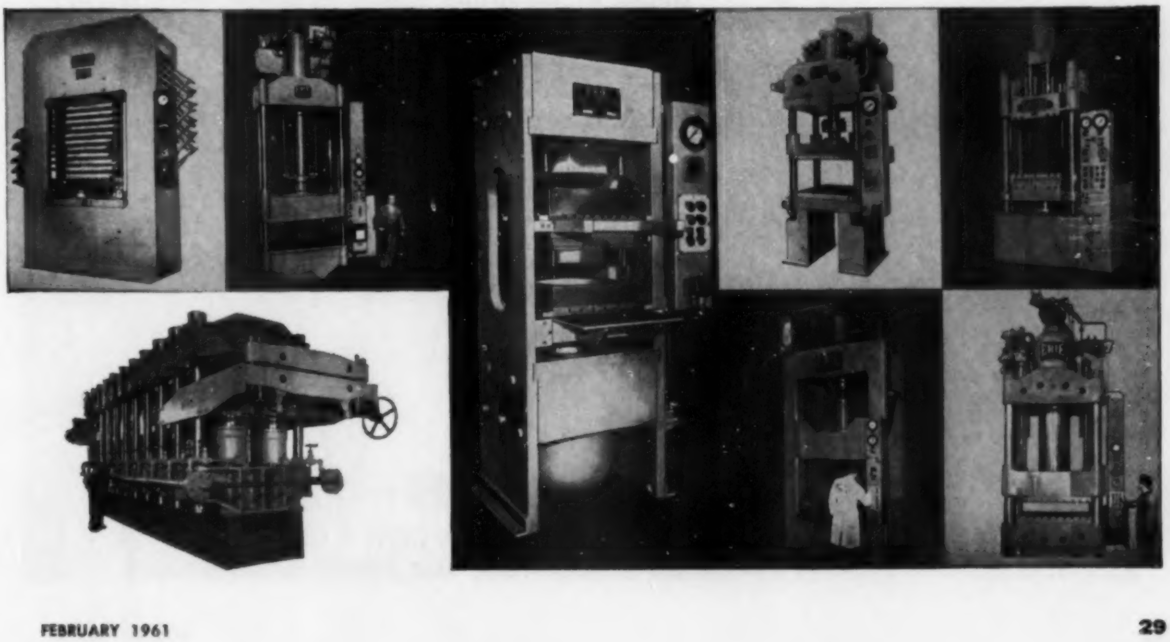
**TERPENE OXIDES:** Limonene Monoxide, alpha-Pinene Oxide.
**DIEPOXIDES:** Dicyclopentadiene Dioxide, Limonene Dioxide.



# "This troublesome mold proved the 24/32 OUNCE LESTER gives us an edge over competition"


"This Tonka Tanker was being tested in other shops on 30 to 40 ounce equipment. The only way it could be run was on a prohibitively long cycle. Anything less, resulted in short shots, weld and sink marks and other finish problems. The job was so tough to run that the mold was suspected of being poorly engineered," says Bruce Schroeder of Empire Plastics, Inc., in Loretto, Minn.

"We put the mold on the L-500-24/32 ounce machine in our all-Lester shop and it took off at 60 shots per hour, running 21 ounces of Implex, a hard-flow, viscous, modified acrylic. The finish was perfect and we got a full shot every time."

The 24/32 ounce Long Stroke Lester with 500 tons of Certified Clamp and adjustable mold stroke of 8″ to 30″ is daily meeting the demands of capacity, clamp and stroke for big, tough jobs up to 40 ounces. Detailed specifications are available on request.

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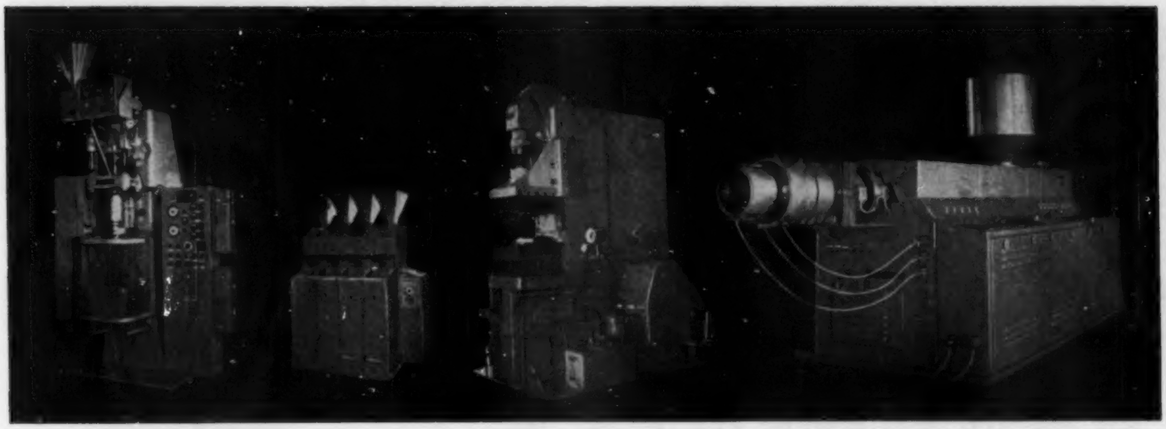

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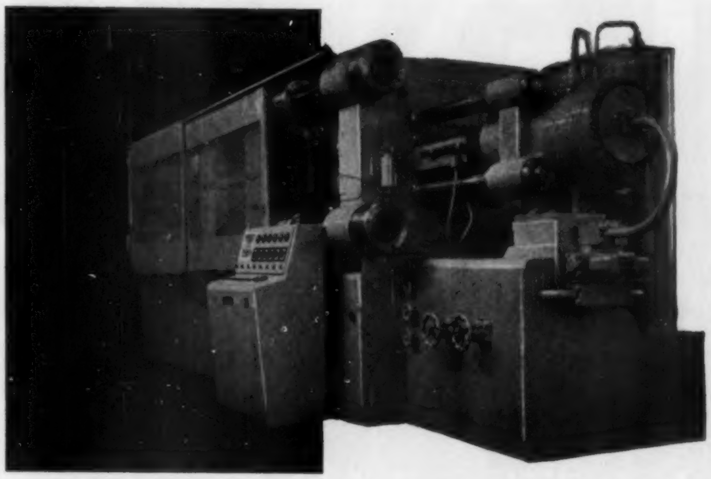

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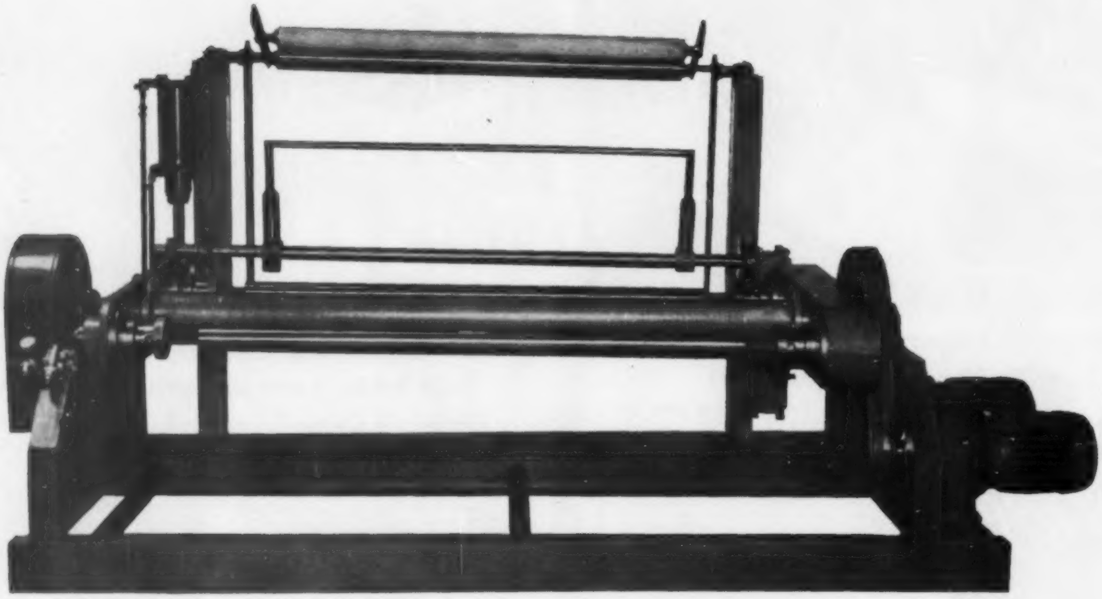
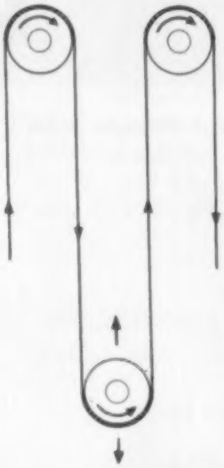


# LEMBO TURRET CENTERWIND
## WITH NEW VARIABLE TENSION CONTROLLER

From beginning to end of every run, sensitive control may be set for all winding conditions . . . from soft, pliable rolls to rolls as hard as desired. The Lembo Turret Centerwind fits all 60" and 80" installations processing extensible films, polyethylene, vinyl, tissue paper, foil, coated fabrics, textiles, etc. Equipped, too, with air-inflated, center tube wind up shafts and cut-off knife.



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Two resins especially tailored for engineered pipe and conduit are MARLEX TR-212 and TR-213. MARLEX TR-414 is recommended for coilable merchant pipe. These resins easily extrude with the dies and machinery regularly used for low and medium density polyethylene. In addition, the working characteristics of these MARLEX resins permit the use of low-cost sizing techniques to obtain a wide range of wall thicknesses. The result is lower costs . . . and a product with greater market appeal.

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*MARLEX is a trademark for Phillips family of olefin polymers.

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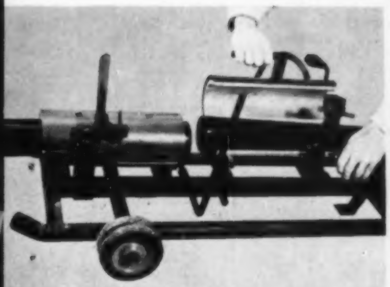
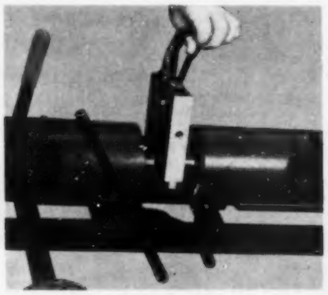
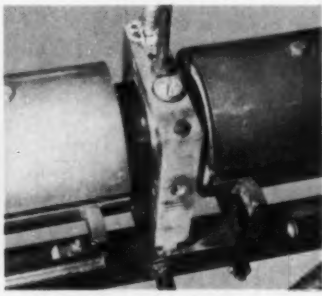


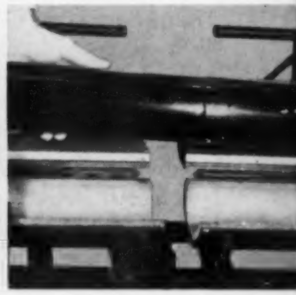
Pipe or conduit is clamped in portable fusion rig.



Thermostatically controlled heating plate is inserted.



Ends to be joined are heated in a matter of seconds.



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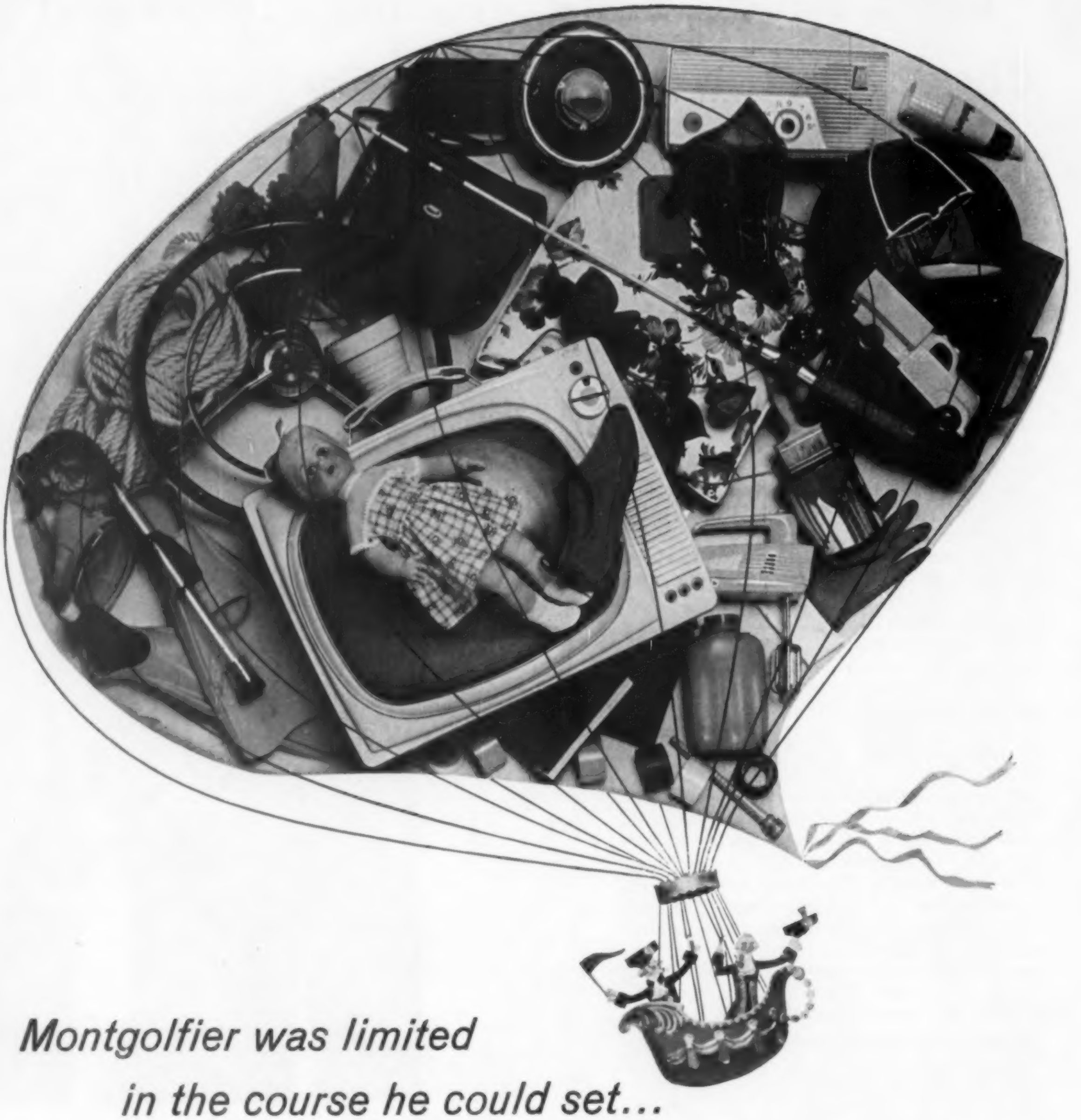

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# THE PLASTISCOPE*

News and interpretations of the news — By R. L. Van Boskirk

Section 1 — February 1961

## *Polyethylene price up—and down again*

The price of conventional low-density polyethylene resin was being raised, Du Pont announced, from 27½¢ to 30¢/lb. as of Feb. 1. The reasons given: rising production costs and the necessity for intensive development expenditures to encourage continued growth of the industry.

Union Carbide Plastics Co., not through a press release but by a letter to customers, declined to go along. The firm stated its belief that current prices, coupled with its long-range marketing plan to broaden the use of polyethylene, offered the best opportunities for improving customers' growth and profit position, and for utilizing the capacity of the industry.

The last big drop in polyethylene price was in August 1960, when Union Carbide cut from 32½¢ to 27½¢ a pound.

Meanwhile, silence from all others concerned. So Du Pont issued another announcement: a return to the 27½¢ price.

PS. Dow, caught in a similar situation in polystyrene, just announced that it would go back to the 18¢/lb. price for that material. The company had set a 19¢ tag for the material as of Jan. 1. However, since the industry did not go along, Dow went back to 18¢—but with great trepidation. The company feels that the low price will have adverse effects on the research, technical service, and merchandising contributions made by materials suppliers.

## *Additional capacities announced*

A second multi-million-dollar polyolefin unit is going to be built by Hercules at its Lake Charles, La., facility. This new facility will double the capacity of the plant, which is scheduled to come on stream this month. The first unit, plans for which were disclosed late in 1959, will produce 60 million lb. of polyolefins per year (10 million lb. above the original design figure). Total annual capacity of the Lake Charles complex will thus be about 120 million pounds. No date for the start of operations for the new unit has been set, but construction has begun.

Total Hercules polyolefin capacity will now be 200 million lb., of which 80 million will be produced at Parlin, N. J., where U. S. polypropylene production began in 1957. Plans call for an equal division of capacity between polyethylene and polypropylene; plant design makes it relatively simple to alter the ratio.

**Dow is stepping up its polyolefin activities.** Plans have just been announced for a second polyolefin plant to be built at its Plaquemine Div. in Louisiana, with start-up operations expected during the second quarter of 1962. The new facility will produce high-density materials by a highly modified Ziegler process; however, whether ethylene copolymers, polypropylene or straight high- and medium-density polyethylene will be produced—and if so, in what proportions—has not been revealed. The first polyethylene plant at Plaquemine was announced in December 1960. The company also reports that its Torrance, Calif., facility will be producing polypropylene by the end of the first quarter in 1961. Altogether, Dow now has polyolefin producing facilities in Texas, Louisiana, California, Michigan, and Ontario. **(More on page 41)**

*Reg. U.S. Pat. Off.

# THE PLASTISCOPE

## *A family of polyethylene resins for blow molding*

Keeping pace with the growth of blow-molded applications, Dow Chemical has announced the development of a family of resins especially tailored for this use. While the company claims that this family will meet most of the requirements of present blow-molding applications, it should be noted that none of them covers the detergent or bleach bottle field.

The resins being offered are as follows: 410M, (density 0.917, melt index 1.5), a general-purpose material for squeeze bottles, toys, and some industrial parts; 510E (D 0.919, M.I. 2), claimed to have good flow properties, and suggested for use in squeeze bottles, tubes, and toys; 400B (D 0.920, M.I. 1.5), a resin that, according to Dow, combines good stress-crack resistance with high clarity and gloss; and is suggested for pharmaceutical and cosmetic packaging; 200B (D 0.923, M.I. 0.7), a high-modulus resin that is said to feature good stress-crack resistance and good flow properties, and is suggested for similar application but requiring more chemical resistance; 550E (D 0.925, M.I. 2), for toys and thin-wall squeeze bottles, and said to combine high clarity, high modulus, and good all-around processibility.

All these resins sell at 27½¢ per pound. In addition, Dow has also developed a film-grade resin (555E, D 0.935, M.I. 2.5) which it states is also suitable for blow-molding applications requiring a high degree of stiffness and good processibility. Cost is 32½¢ per pound.

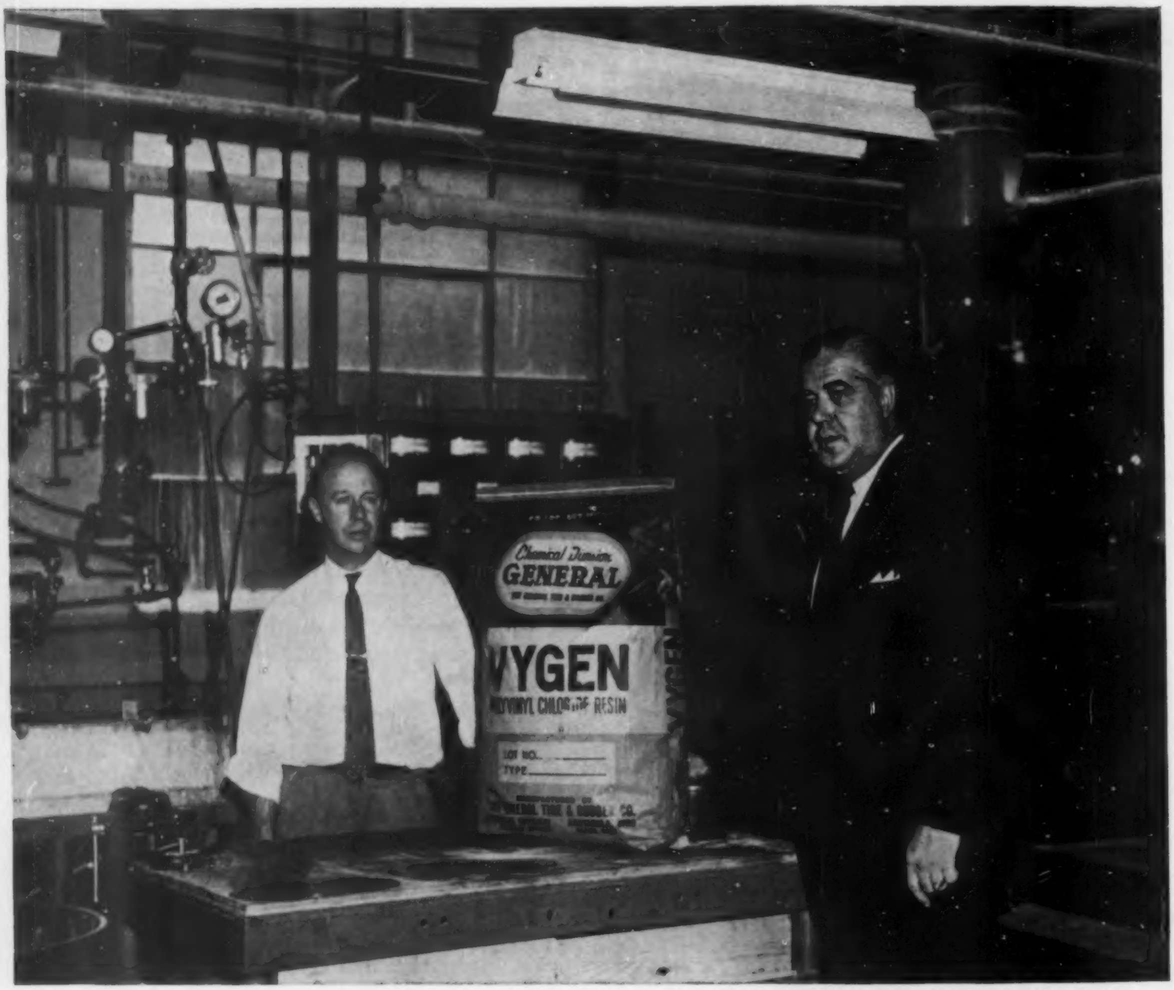
## *Polypropylene in Japan*

While U. S. polypropylene capacity grows apace, several facilities for producing polypropylene in Japan have now been announced. The first of these is a joint undertaking between AviSun Corp., Philadelphia, Pa. and Shin Nippon Chisso Hiryo, K. K., Tokyo, to manufacture and market polypropylene resin, film, and fiber in Japan. Construction of a 30-million-lb./yr. plant has been started, and a completion date has been set for sometime in 1962. This agreement, said to be the first in the polypropylene field for an American company, has received approval by the Japanese Ministry of International Trade and Industry.

In addition to this cooperative venture, three Japanese companies are also building independent polypropylene facilities: Mitsubishi Petrochemical Co. and Mitsui & Co. are each planning a 20-million-lb./yr. facility, and Sumitomo is scheduling a 10-million-lb./yr. unit (all figures are approximate).

## *A trend towards self-sufficiency*

A major plant for the production of such hydrocarbons as ethylene, benzene, and naphthalene will be built by Monsanto Chemical Co. at Chocolate Bayou, Texas, as part of the company's move toward self-sufficiency in hydrocarbon raw materials for its chemical processes. Monsanto began to move toward acquisition of sources of petroleum raw materials in 1955 when it merged with Lion Oil Co., a producer of petroleum and petroleum derivatives. The new project will make the company even more basic in chemicals produced from petroleum. The plant will be constructed on a 3000-acre site in Brazoria County near Alvin, Texas, and will reportedly include facilities for producing ethylene at an annual rate of 500 million lb., benzene at 42 million gal./yr. and naphthalene at 50 million lb. a




Thomas Tann, Extruded Plastics Dept. Head, and D. S. Watkins,
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## VYGEN specialized PVC resins

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**Vygen 123** —An extra-high-molecular-weight resin for dielectric heat-sealing applications

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year. The plant will also produce propylene, cumene, phenol, acetone, ethyl benzene, and other hydrocarbon resins. It is scheduled to begin operation in 1962.

**Monsanto's vinyl chloride** capacity will be doubled by July of this year when the company's vinyl chloride monomer plant at Texas City, Texas goes on stream. It will have an annual capacity of 150 million pounds. The new figure represents a 50% increase in present capacity and will be the result of construction now in progress. For the time being, the expanded plant will use acetylene and ethylene from current Texas City production, but in 1962 will begin drawing quantities of ethylene by pipeline from Chocolate Bayou.

## New facilities for melamine crystal

Announcement has been made by Allied Chemical Corp. that its Nitrogen Div. will install facilities for the production of melamine crystal. The new facilities will have a capacity to produce upwards of 20 million lb. of melamine crystal per year —an amount which Allied claims is sufficient to supply the requirements for the melamine molding resins made by its own Plastics Div. and also to provide a substantial quantity for sale to other melamine consumers. The plant, expected to be completed early in 1962, will produce crystal by a process developed by the Nitrogen Div. License has been obtained from American Cyanamid Co. for the basic patents covering production of melamine crystal from urea.

## Melamine dinnerware industry organizes new trade group

Molders of melamine dinnerware as well as raw materials suppliers have organized a new trade association under the name of Melamine Dinnerware Guild of the Society of Plastics Industry. At an organization meeting held at Chicago on Jan. 18, several suppliers of foil for use in decorated dinnerware were also in attendance, and it is expected that they will participate in the group's activities.

The S.P.I. has long had an established division on melamine dinnerware. Members of that division included both molders and material suppliers. The new group is essentially a reconstitution of that division.

At this time, the Guild is still in its formative stages and no program of action has been finalized. But when it starts functioning full-scale, it will, in effect, be superseding the functions of the Melamine Council though its scope of action will be much broader. The Melamine Council, formed about three years ago with Allied Chemical backing to promote melamine dinnerware and brandnames, discontinued operations as of the beginning of this year. Some of the promotion functions will be taken over by the new Guild, which in addition will be concerned with standards, market statistics, manufacturing techniques, etc.

While the Melamine Council was essentially dominated by one resin supplier, the Melamine Guild will be basically in the hands of molders.

## New manufacturer of acrylic

American Cyanamid Co., under a license from Imperial Chemical Industries Ltd., becomes the newest manufacturer of methyl methacrylate. The methyl methacrylate monomer will be manufactured in a unit to be built at the Fortier plant near New Orleans, La., where the company now produces acrylonitrile. Hydrocyanic acid,

a raw material for acrylonitrile, also is a principal raw material in the manufacture of methyl methacrylate. Initial monomer capacity will be 30 to 35 million pounds. American Cyanamid's plans also call for the construction of additional production units to convert the methyl methacrylate monomer into molding powder as well as cast sheets.

This development marks the return of American Cyanamid to the thermoplastic industry. Since the company discontinued production of methylstyrene in 1959, its plastics activities have been essentially limited to the thermosets. It also marks another shift in the rapidly changing methacrylate picture. Last month, Escambia Chemical announced entry into this field. American Cyanamid's announcement brings the number of major methacrylate producers to four (the other two: Rohm & Haas and Du Pont). Whether American Cyanamid will be producing only general-purpose molding material, or whether it will be making copolymers too, is not known at this time.

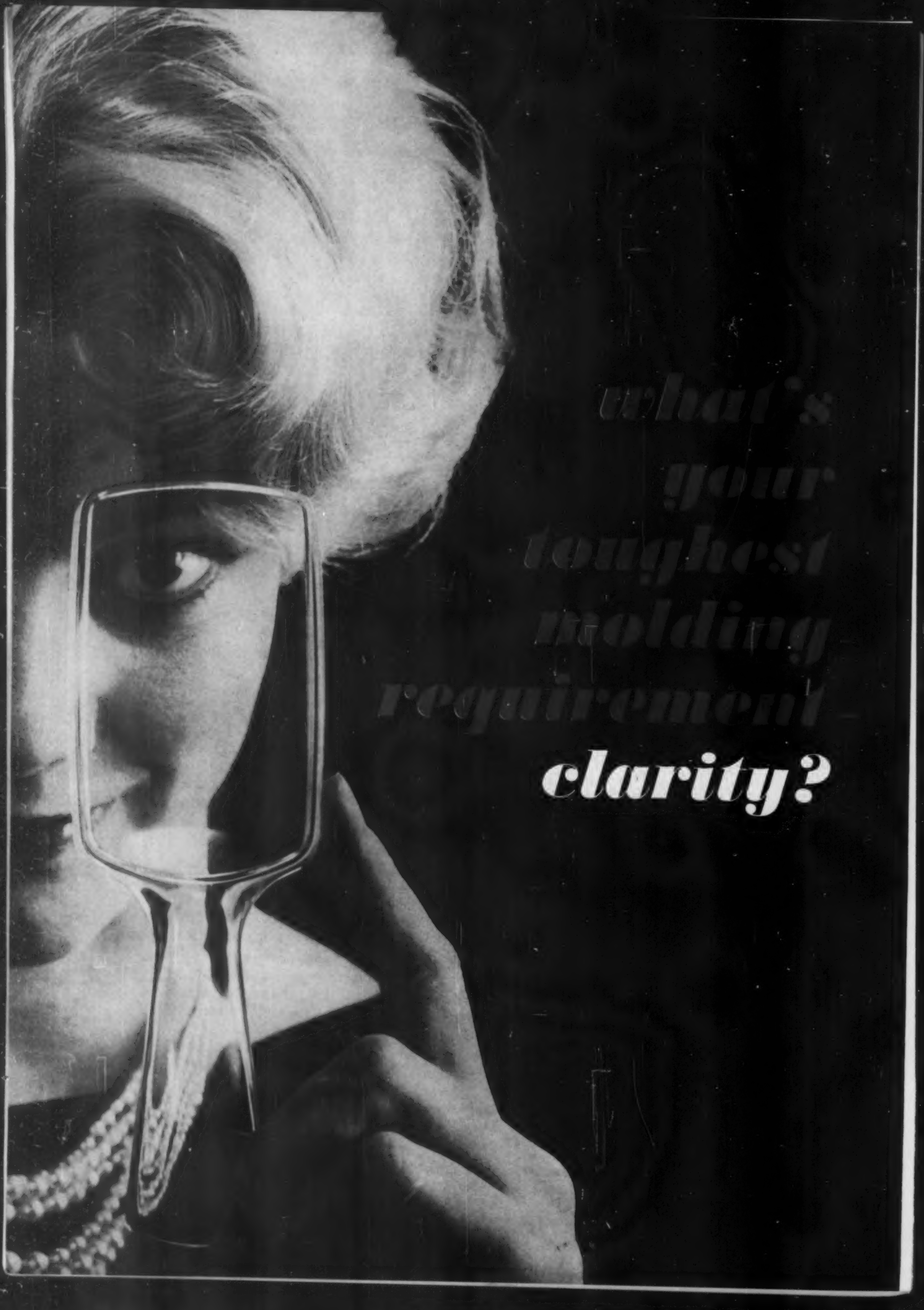
### *New developments in foam*

Anyone who has been watching the plastics industry over the past few years has become aware of the rapid growth of its foam segment. So it is not surprising that the impetus that is being generated would result in new developments designed to expand the growing market base still further. Several such developments were announced by Dow Chemical. One is a rigid urethane-foam board featuring high solvent resistance, high heat distortion and low thermal conductivity. Expected application for these boards, tradenamed Thurane, include use as insulation in refrigeration appliances, on pipe and in refrigerator trucks, as roof insulation, in low-temperature space insulation, and as sandwich panel materials. Thurane will be priced 90% higher than Dow's Styrofoam in equal thicknesses, but its superior insulation properties will make its price only 20% higher in terms of thicknesses needed for equivalent insulation.

The second new foam product is a blue Styrofoam insulation board exhibiting improved flame-retardant properties. Designed for use in major construction applications, the new product is self-extinguishing by ASTM D1692-59T; will be priced "competitively;" and will replace the company's Styrofoam 33, which was sold at a slight premium.

The third product is pre-colored expandable polystyrene pellets. The new pellets are said to provide more intense colors unavailable until now because of the lower temperatures at which dry-color surface-coated beads must be fused. The beads are made through a continuous manufacturing process to insure uniformity of color and size—0.025-in. diameter, 0.060-in. length. Products molded of the new pellets are said to be color-fast, and if the surface is chipped away the inner core will show the same color as the skin. Tradenamed Pelaspan 101, and aimed primarily at packaging, novelty and general-purpose molding where color is important, the colored pellets—red, green, blue, yellow, and black—are priced at 42¢/lb. in 20,000-lb. lots, and 40¢/lb. in 50,000-lb. lots. Uncolored pellets, which can be used for molding large sections, such as insulation board, also are uniformly produced but are available in three different sizes: These are priced at 37¢/lb. in 20,000-lb. lots.

**For additional and more detailed news see Section 2, starting on p. 212**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Rexall Chemical Company
8909 W. Olympic Boulevard
Beverly Hills, Calif., OLive 3-1300

| Properties | Unit | *Elrex* 100 Series | *Elrex* 200 Series | Test Method ASTM |
|---|---|---|---|---|
| Tensile Strength | psi | 6800-7800 | 6500-7500 | D-638 |
| Elongation | % | 1.5-3.0 | 1.0-2.5 | D-638 |
| Tensile Modulus | psi | 450,000-480,000 | 470,000-500,000 | D-638 |
| Flexural Strength | psi | 9000-12000 | 8000-11500 | D-790 |
| Izod Impact ½″ x ½″ | ft. lbs. per in. notch | .35-.50 | .30-.45 | D-256-56 |
| Hardness | Rockwell "M" | 70-80 | 70-80 | D-785-51 |
| Deflection Temperature Under Load | °F at 264 psi fiber stress | 175-182 | 170-178 | D-648-56 |
| Thermal Expansion | in./in. | .0003-.0004 | .0003-.0004 | D-696-44 |
| Specific Gravity | — | 1.05 | 1.05 | D-752-50 |

The above data represent average laboratory values by the methods indicated and should be so considered. Since processing variables contribute heavily to product performance, this information should serve only as a guide. To the best of our knowledge, the data are accurate.

Elrex polystyrene is also sold by A. Schulman, Inc.

Akron 9, Ohio
790 Tallmadge Avenue
HEmlock 4-4124

Boston 16, Mass.
738 Statler Building
LIberty 2-2717

New York 22, N. Y.
460 Park Avenue
MUrray Hill 8-4774

Chicago 45, Illinois
2947-51 W. Touhy Avenue
ROgers Park 1-5615

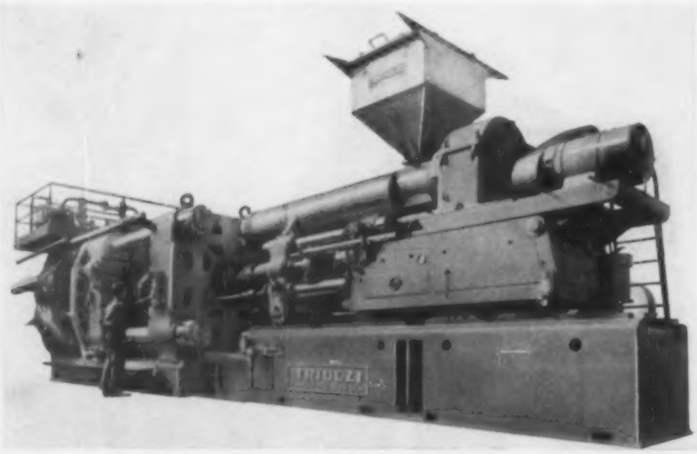
Los Angeles 5, Calif.
Room 730, Texaco Building
3350 Wilshire Boulevard
DUnkirk 5-3018

East St. Louis, Illinois
P.O. Box 310
14th and Converse Streets
UPton 5-2800

**REXALL CHEMICAL COMPANY**
P.O. Box 37, Paramus, N. J.
A Division of Rexall Drug and Chemical Company

# NEW MACHINERY-EQUIPMENT

**Specifications, claims made, and prices appearing in these pages are those of the manufacturers or sellers of the machinery and equipment described, or their agents.***




### *Injection machine*

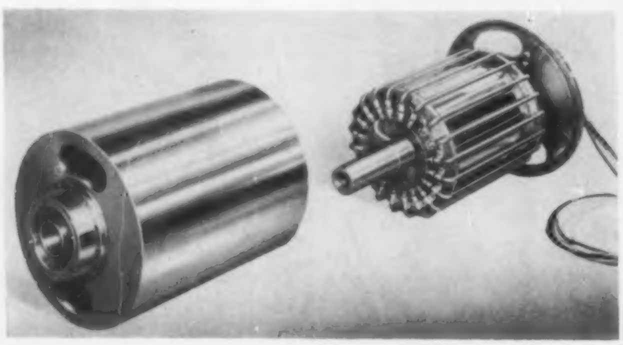
Truly monstrous in size, this 425-oz. Model 12/350/2200 injection machine was designed for the molding of such objects as refrigerator liners and large housewares. A 6½-in., variable-speed screw extruder is used as a pre-plasticator. The machine is equipped with a novel clamp system which uses two auxiliary hydraulic cylinders to open and close the molds while the main clamp cylinder is used to apply the molding clamp pressure. The unit can be operated either automatically or fully manual. *A. Triulzi, Via Valbe, 56, Novate (Milan), Italy.*

**Specifications:** Triulzi Model 12/350/2200 injection machine

| | |
|---|---|
| Clamp force, tons | 2500 |
| Max. injection pressure, p.s.i. | 22,000 |
| Injection capacity, oz. | 425 |
| Plasticating capacity, lb./hr. | 770 |
| Max. mold thickness, in. | 47 |
| Min. mold thickness, in. | 28 |
| Moving platen stroke, in. | 59 |
| Platen dimensions, in. | 83 by 79 |
| Machine dimensions, ft. | 58 by 11 by 15 |

### *Heating rolls*

Newly designed heating rolls, called Thermaroll, are suitable for use in processing laminates, embossed sheeting, and other thermoplastic films. Rolls are heated internally by electrically powered radiant heaters (at right in illustration below) but can also be supplied with a liquid heat-transfer system. They are available in models delivering temperatures ranging from a minimum of 275° F. to 1000° F., and in diameters from 6 to 30 inches. *Thermal Inc., 9400 Robinson Rd., Franklin Park, Ill.*



### *Foam block mold*

Specifically designed for foaming large blocks of low-density expanded polystyrene, Vaporex molds can be supplied for slabs as large as 240 by 48 by 20 inches. Steam chest is made of non-corrosive light metal castings; interior and exterior surfaces are machined. Steam chest and the mold shell are not rigidly connected. The cavity walls are made of perforated light metal plate. Each steam chest element has two separate passages within the mold wall. One set is used for preheating and cooling, the second set injects steam through numerous holes directly into the mold cavity. Two cooling systems are available: a cored or a spray system. The mold shell is made of steel and designed for steam pressures of 35 to 40 p.s.i. About 2 lb. of steam at 10 to 25 p.s.i., applied for 20 to 30 sec., is needed for each pound of foam with 1 lb./cu. ft. density. With proper piping, a total cycle is 6 to 7 minutes. Loading is from above, either by hand or through a patented mold charging device. Operation is semi-automatic. Hydraulic devices and air cylinders close, open, lock, lift, and lower the mold lid, and eject the foamed block. Automatic control is available. *Moldex Co., P. O. Box 51, Yonkers, N. Y.*

### *Resin mixer-dispenser*

The Graco Hydra-Cat uses pneumatically powered, reciprocating, positive displacement pumps to meter and proportion each of two reactive resin components, filter them, and transfer them through separate hoses to a mixing and dispensing gun. In the gun, the materials are blended and homogenized and the mixed resin is applied by airless spray. Pre-determined cylinder assemblies provide 13 mix ratios ranging from 1:1 to 4:1. Separate feeds eliminate the possibility of clogging the system with cured resin prior to the dispensing gun. Materials are pre-blended in the gun by a static labyrinth mixing chamber and homogenize as they pass through the small orifice of the gun at high pressure. *Gray Co., Inc., 1059 Sibley St., N. E., Minneapolis 13, Minn.*

**(More on page 50)**

* Prices are deemed to be F.O.B. sellers' plants (unless otherwise stated), are for "standard" models, and are subject to change without notice. The publishers and editors of **Modern Plastics** do not warrant and do not assume any responsibility whatsoever for the correctness of the same or otherwise.

# Proof of Satisfaction!

## Brighton Plastics re-ordered VAN DORN presses again and again

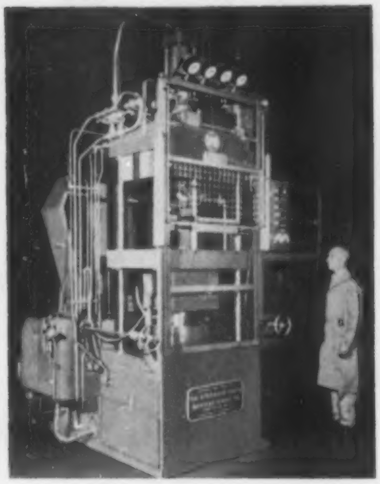
Several years ago Brighton Plastics of Rochester installed a Van Dorn H-250 to produce nylon gears for electric clocks. They inject gears in a multiple cavity mold at a production rate of 5 shots per minute. The Van Dorn press performed so well that Brighton ordered another, and later still, a third.

Van Dorn presses mold nylon better because they insure:

1. Better material control
2. Easier maintenance of close tolerances
3. Lower mold investment
4. Less waste in purging
5. Automatic cycling

*The outstanding features of Van Dorn presses for molding all thermoplastics are fully described in literature available upon request.*

THE Van Dorn IRON WORKS CO.
2685 EAST 79th STREET
CLEVELAND 4, OHIO



### Transfer press

This H-P-M 100-ton, upward-acting molding press, equipped with a top-mounted transfer cylinder, was designed for the manufacture of communications equipment and other phenolic parts. It is completely automated, with automatic loading, feeding, and preheating equipment. Clamp stroke is fully adjustable up to 12 inches. Size of upper grid and platen is 36 by 26 in. and daylight between platen and head is 30 inches. Unit uses a 10-ton hydraulic system to eject parts. Force of the transfer cylinder is adjustable from 18 tons to a maximum of 25 tons. Stroke of transfer ram is 9 inches. *The Hydraulic Press Mfg. Co., Div. of Koehring Co., Mt. Gilead, Ohio.*

### Flange former

Known as the Model C, this continuous plastic double-flange forming machine makes 90 or 180° flanges on any thermoplastic sheet thicker than 5 mils and is said to be capable of folding up to 3000 blisters per hour. It folds blisters to accommodate cards from 1.25 in. wide up to a maximum of 14 in., with card thicknesses up to ⅛ inch. Folding is done as the plastic moves across a pair of heated die bars. Machine is equipped with a variable-speed drive and dual thermostatic heat controls to monitor the proper heating of the sheet for folding. *Tronomatic Machine Mfg. Corp., 25 Bruckner Boulevard, New York 54, N. Y.*

### Granulator

Called the M-400, this 500 lb./hr.-capacity machine has heavy-duty knives with double shear action and will handle small purgings and lumps as well as large rejects, sprues, runners, etc. The granulator is available in both standard- and wide-throat models. Standard throat is 8 by 20 in.; wide throat is 12 by 20 inches. Unit occupies floor area 34¾ by 35¼ in., is mounted on casters. *Ball & Jewell, 22 Franklin St., Bklyn., N.Y.*

### Ovens

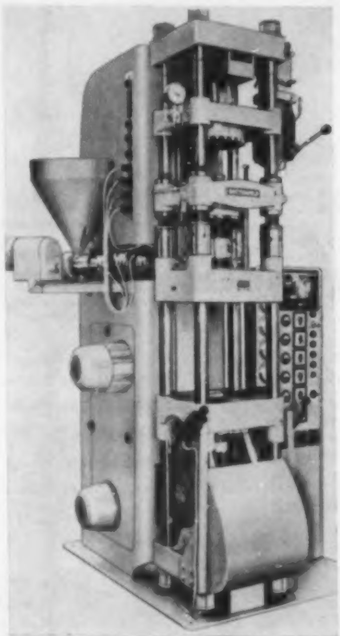
Delivered either assembled or ready for assembly, these ovens can be heated by steam, gas, or electricity. Uses include curing plastic parts, preheating of materials, and similar work of a batch nature. The units feature insulated-panel construction and are equipped with double loading doors. A circulating fan distributes the hot air, moving it from one side of the oven to a positive exhaust on the other side. All controls are mounted on the oven as delivered, and all piping or wiring is complete for easy installation. *The DeVilbiss Co., 300 Phillips Ave., Toledo 1, Ohio.*

### Precision knife cutter

Designed primarily for the granulating of thin polyethylene film scrap from 1 to 2 mm. thick and up to 48 in. wide, this heavy-duty machine can control knife clearances within extreme accuracy. It has been actually demonstrated that knife clearances can be held to within 3 mm. because of the rigid and accurate construction of the cutter. The "shear cut" rotor cutting circle is 20 in. in diameter. A built-in knife grinder attachment is provided. *Sprout-Waldron & Co. Inc., 130 Logan St., Muncy, Pa.*

### Plastisol mold oven

Designed to meet the needs of molders of hollow vinyl plastisol products is the Economy double rotation oven. In it 36-in. mold plates swing with large oven clearance to accommodate popular commercial molds. The unit was engineered for continuous 24-hr. operation and is flexible enough to mold-cast economically various sized pieces. The oven is automated to eliminate heavy lifting of mold mounting plates. Loading door operation is automatically interlocked with the cycle controls. Oven is gas-fired and construction is extra-heavy to minimize breakdown. Made by *Brooklyn Blower & Pipe Corp., 78-80 Kosciusko St., Brooklyn 5, N. Y., and distributed by Suffolk Assocs., 107 E. 38th St., New York 16, N. Y.*



**BATTENFELD** Model BSM-40VP-V 3½-oz. vertical injection press has screw pre-plasticator (not shown): feed-in is partially visible at middle-left.

### Injection machine

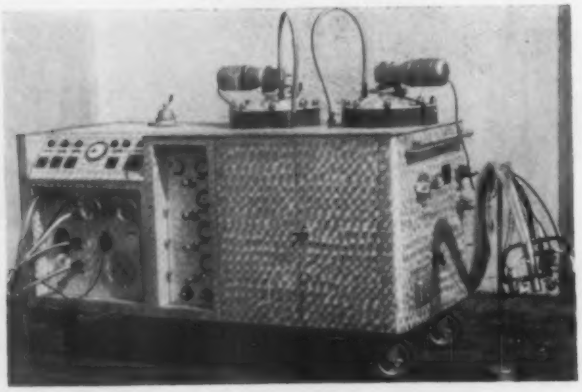
Designated Model BSM-40VP-V, this 3½-oz. injection machine is a vertical version of the 3½-oz. horizontal machine produced by the maker. It is equipped with a preplasticating system based on a horizontal screw extruder which is common to this manufacturer's line of equipment. The vertical design makes this model especially suited for the production of injection molded parts with inserts. Major specifications are shown in the accompanying table. *Battenfeld Corp. of America, 959 W. Grace St., Chicago 13, Ill.*

**Specifications:** Battenfeld BSM-40VP-V injection machine

| | |
|---|---|
| Max. shot capacity, oz. | 3.5 |
| Max. dry cycles per hr. | 600 |
| Plasticating capacity, lb./hr. | 27 |
| Max. injection pressure, p.s.i. | 17,750 |
| Max. molding area, sq. in. | 31 |
| Nominal screw diam., in. | 1 11/64 |
| Injection piston diameter, in. | 1 31/32 |
| Mold clamping pressure, tons | 50 |
| Mold opening stroke, in. | 7⅞ |
| Maximum mold daylight, in. | 9 27/32 |

(More on page 52)

 (From page 50)



### Self-contained and mobile RP spray-up system

Three models of the M.A.S. system are available for use in different applications. Model SP VI is standard and designed for use in stationary in-plant operations. Model BK III is a portable unit for use in the field, and Model SP A 2 is a compact design for spray-up jobs in confined areas, such as in large tanks. All three units use a spray gun which shoots separately glass fibers and the two resin components; mixing of the ingredients takes place in mid-air, after they have left the gun and before they impinge on the surface being sprayed. A cutter element produces any fiber length between 0.6 and 4 in., using a 6-strand roving feed which may be mixed in any ratio between 1:1 and 1:5 with the resin phase. A timer is provided so that equivalent amounts of material can be sprayed per application. Each unit is equipped with two resin tanks of 110-lb. capacity and a solvent tank for gun purging. All controls for this European-made RP spray-up system are on a low 24-v. electrical supply for safety reasons. *Aust & Schüttler u. Co., M. A. S.—Kunststoffmaschinen G.m.b.H., Graf-Adolph-Strasse 81, Düsseldorf, Germany.*

### Weathering machines

For the weather testing of plastics, the Xenon Arc Fadeometers and Weatherometers use a Xenon lamp which has a spectral-energy distribution very close to that of natural sunlight. The water-cooled 6000-w. lamp is equipped with a replaceable burner which has a rated useful life of 2000 hours. The specimen rack has a diameter of 37¾ in. and will accommodate up to 54 samples measuring 3 by 9 in. in size. Weathering cycles, black panel temperature, as well as exposure and light intensity are automatically controlled. *Atlas Electric Devices Co., 4114 North Ravenswood Ave., Chicago 13, Ill.*

### Moving-web viewer

By means of a special optical system employing an oscillating mirror, this device permits the visual inspection of different repeat lengths of patterns on plastic webs while the web is in motion on processing equipment. Although the web is in motion, the pattern being viewed appears to stand still. Careful inspection of colors, structure, or register is possible on sections of materials measuring up to 45 in. long and running at speeds up to approximately 1500 feet per minute. *Mt. Hope Machine Co. Inc., Taunton, Mass.*

### Process fluid cooler

This unit is a two-zone temperature-control unit capable of delivering chilled liquid (anti-freeze solution) at below-freezing and heated water up to 250° F. It is available in various refrigeration horsepowers and heating capacities. It can be operated as a portable unit as well as in a stationary location. Each zone of the cooler is individually controlled, so that either portion of the unit can be run independently of the other. The cooler is also available as a single-zone unit. *Saren Inc., 816 North Kostner Ave., Chicago 51, Ill.*

### Pressure and temperature recorder

Designed to be used in conjunction with extruders, electronic potentiometer recorder in the 8000 series is self-contained and uses a constant voltage source instead of the usual standard cell for standardization. The new unit will record one or more pressures, and up to 23 temperatures. The standard model can be used for temperatures from 0 to 800° F., and pressures from 0 to 16,000 p.s.i. Other ranges are available. Zero and span adjustment for the pressure range of the instrument is independent of the temperature range. *Wheelco Instruments Division of Barber-Colman Co., Rockford, Ill.*

### Mold temperature controller

For injection molding, this cooling system automatically controls the temperature of mold water to variations of less than ½° F. Unit is only 20 in. long by 10 in. wide by 10½ in. high. A water pumping system supplies high velocity, high volume electrically heated water without using bulky reservoirs. Circulating water temperatures can be quickly changed in 1 to 2 minutes. Operating temperatures from 40 to 250° F. can be maintained. Weighing approximately 100 lb., the unit is easily moved. *Mokon Division of Protective Closures Co. Inc., 2207 Elmwood Ave. Buffalo 23, N. Y.*

### Injection machine

The Trueblood Unimatic Model B-200 injection machine was especially developed for the molding of vinyl electrical cord sets and plugs, but will be adapted by the manufacturer for molding any product. The vertical clamp is so designed that no tie bars are used, thus allowing easy access to the mold for insert molding. Injection is perpendicular to the clamp, feeding the mold on the parting line. Typical production rate for NEMA-standard female plug is 600 to 900 per hour. Standard double-contact plugs can be run at about 1000 to 1200 per hour. Other production specifications of this unit are shown in the table below. *Union Tool & Engineering Co., 332-336 Jones St., Dayton 10, Ohio.*

**Specifications:** Trueblood Unimatic Model B-200 injection machine

| | |
|---|---|
| Shot capacity (in vinyl), oz. | 6 to 8 |
| Dry cycles per hr. | 600 |
| Plasticating capacity, lb./hr. | 150 |
| Maximum injection pressure, p.s.i. | 20,485 |
| Injection ram diameter, in. | 2 |
| Injection ram stroke, in. | 9 |
| Mold opening, max., in. | 5 |
| Maximum mold casting area, sq. in. | 20 |
| Mold clamp force, tons | 150 |

(More on page 54)

—the revolutionary

# PRODEX-HENSCHEL

U.S. Pat. No. 2-945,634

PRODEX HENSCHEL

# MIXER

for INTENSIVE

- √ Resin Dryblending
- √ Pigment Dispersion
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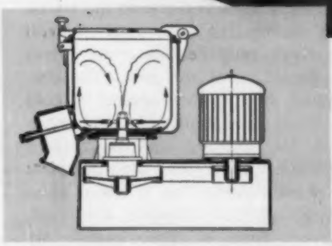

**Hundreds of PRODEX-HENSCHEL MIXERS are being successfully used for...**

- √ Plasticized Vinyl Dryblending
- √ Rigid PVC Dryblending
- √ Pigment Dispersion in Polymers
- √ Acetate and Butyrate Dryblending
- √ Filler Mixing with Thermosets
- √ Fibre Mixing with Polyesters
- √ Dry Coloring

In the **PRODEX-HENSCHEL MIXER,** a specially designed propeller-like impeller rotates at peripheral speeds of about 150 ft/second. The centrifugal action of this impeller creates a rapid and continuous flow of the mixer charge through the impeller blades. The high impact velocity of the blades and their shearing action break down agglomerates and cause intimate dispersion of all ingredients. The impeller is designed for large energy transfer to the mixer charge so that rapid mechanical heating is also obtainable. The heating rate is controlled by selection of the proper speed on the multiple speed motor drive. Mixing cycles for complete dispersion are usually so short that heat build-up is negligible where it is not desired. The mixers are jacketed for heating or cooling, and a stock temperature indicator is provided for continuous observation of the batch temperature.

PRODEX-HENSCHEL MIXERS ARE AVAILABLE IN FOUR SIZES

| MODEL | 2JSS | 18JSS | 35JSS | 115JSS |
|---|---|---|---|---|
| TOTAL CAPACITY (cu. ft.) | 0.37 | 2.7 | 5.3 | 17.5 |
| USEFUL CAPACITY (cu. ft.) | 0.25 | 1.8 | 3.5 | 11.5 |
| MOTOR H.P. | 2 | 15 | 32 | 92 |

Also available in vacuum-tight construction for vacuum extraction with large material surface exposure and continuous agitation.

The **PRODEX-HENSCHEL MIXER** is cleaned in minutes, due to its smooth interior design. All contacting surfaces are made of stainless steel. It is easily loaded and discharged while running.

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PRODEX

Write for illustrated bulletin M-1.

**PRODEX CORPORATION**
**FORDS, NEW JERSEY** • Phone HILLCREST 2-2800

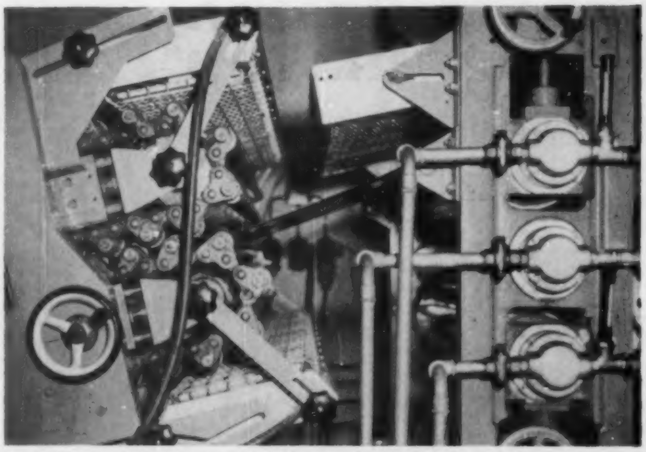
 (From page 52)

### Hot stamper

Said to be capable of producing 3600 stampings/hr., the Rainmark Rotary Hot Stamping Machine Model 220 has a rotary table mounted on a sturdy anvil support to insure positive control of stamping pressures. The 19-in. rotary table is adjustable to provide either 6 or 12 stamping stations. The unit has a net weight of 800 lb., measures 42 by 38 by 59 in., and requires a 220 v., 3-phase electrical power supply. The unit is made in England but is stocked F.O.B. New York by *The Rainville Co. Inc., 839 Stewart Ave., Garden City, N. Y.*

### Vacuum former

For pilot runs and production of small parts, the Lab-Master vacuum-forming machine is equipped with sandwich heaters capable of handling any thermoplastic sheet from 1 to 186 mils thick. Maximum molding area is 14 by 20 inches. The machine is equipped with an adjustable clamping frame. Maximum depth of draw is about 10 inches. The machine is specifically designed for the following operations: vacuum snap-back, plug assist, form and trim, blow molding, mechanical forming, billow or air cushion, pressure forming, inverted vacuum and drape molding. *Comet Industries, 9865 Franklin Ave., Franklin Park, Ill.*



**REIFENHÄUSER** corrugation equipment, showing sheet issuing from the finishing and polishing unit (right) and passing on between the chain driven intermeshing corrugating rollers (left). Infra-red heaters are set above and below corrugators.

### Corrugated sheet machine

The Reifenhäuser plastic sheet corrugating line is sold as a packaged unit consisting of a 4.7-in. Type S120 extruder, a specially designed sheeting die, a set of 7.7-in.-diam. oil-heated polishing and sizing rolls (Types GM 160 or GM 120, each roll equipped with its own heater for better control), and the Type WPM 160 sheet-corrugating machine paper. For the extrusion of rigid PVC, the extruder is equipped with a high-torque screw designed especially for rigid polyvinyl chloride, and a newly designed fishtail type extrusion die, with channels contoured for optimum flow conditions.

This die construction permits continuous, uninterrupted extrusion of rigid PVC without the danger of burning or decomposition. The die is capable of producing sheet up to 3/16 in. thick and is nominally either 43 or 60 in. wide depending on the size of equipment ordered. After extrusion, the sheet passes from the die over the oil-heated rolls. These operate between 150 to 200° F. for rigid PVC but can be operated as high as 250 to 300° F. When extruding rigid vinyl, typical sheet production rate is about 3 to 6 feet per minute.

After passing over the rolls, and prior to corrugation, the sheet is kept warm by infra-red heaters mounted on the corrugating machine close to the rolls. In the corrugating machine the sheet passes between intermeshing, unheated rollers, which corrugate the sheet transverse to the width. The corrugating rollers travel with the sheet, propelled by chain drives on the edges of the rolls. The corrugated sheet is then cooled by cold air blasts from both sides and issues from the forming unit in finished condition. Price of the complete sheet corrugating line is about $60,000, F.O.B. U. S. seaports, duty paid. Delivery time is approximately six months. *Reifenhäuser KG Machinenfabrik, Troisdorf, Bezirk Köln, Germany.* Handled in the United States by *Heinrich Equipment Corp., Port Authority Building, 111 Eighth Ave., New York 11, N. Y.*

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### . . . Machinery in brief

▶ An interleaving and separating paper called Strip-Ease. Made of silicone-coated kraft paper, it will not stick to tacky plastic sheets and similar materials. Durable enough for multiple re-use. *Riegel Paper Corp., 260 Madison Ave., New York 16, N. Y.*

▶ A Ferrofilter Electromagnetic Separator (Model 48-V) suitable for use in hopper-feeding extruders and molding machines. Device removes ferrous tramp metal which may be in plastic feed; protects equipment. *S. G. Frantz Co., Inc., Brunswick Pike and Kline Ave., Trenton, N. J.*

▶ A 4-, 6-, 8-, 12-, or 24-station dial table for use with AcroMark hot stamping presses. *Acromark Co., 5-15 Morrell St., Elizabeth, N. J.*—End


## .... with this MASTER-PLANNER SCALE MODEL OFFICE LAYOUT by APPLIED RESEARCH Corp.

Here's the long awaited answer to modern office planners, architects and efficiency engineers . . . the Master Planner scale model kit by Applied Research Corporation of Erie, Pa. With floor-space grid and these multi-combination 3 dimension scale components, office partition and equipment layouts can be made in a few minutes.

The Master Planner Kit contains a complete variety of parts that form limitless combinations of desks, bookcases, chairs, filing cabinets to meet all the requirements of office size and design . . . and to do it in a fraction of the time required to make drawings and prints.

Moreover, these quickly completed 3 dimension scale layouts can be photographed by office planners for discussion and decision at a great cost saving. No misunderstandings, no costly errors, no time wasted.

Furniture and partition kits are available separately or in combination. Molded parts are in two-tone complimentary shades of beige and brown. Each kit is furnished with a grid layout planning board and a corner wall section that adds realism to the layouts. The modern office comes alive quickly through the use of Applied Research Corporation's Master Planner.

The Master Planner is "modern magic" to prove the ancient Chinese Proverb that one picture is worth more than 10,000 words.

*Precision Molded by Quinn-Berry where the Unusual is Routine*

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Turner 4-3484

**DETROIT 35, Mich.**
W. J. Montgomery Co.
16577 Meyers Road
Diamond 1-3454

**EAST ROCHESTER, N. Y.**
Dynatherm, Inc.
607 West Commercial Street
Phone: Ludlow 6-0082

**KNOXVILLE, Tennessee**
Harold J. Molloy
2100 Alice Ave.
P. O. Box 3207
Phone: 2-3911

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# WORLD-WIDE PLASTICS DIGEST*

**Abstracts from the world's literature relative to plastics. For complete articles, send requests direct to publishers. List of addresses is at end of this section.**

## General

*Standardization and pipes.* F. W. R. Wijbrans. Plastics (London) *25*, 358-59 (Sept. 1960). There are many problems involved in establishing uniform standards for plastics pipe. The lack of uniformity of opinion concerning methods of establishing standards and the importance of ISO contributions are discussed.

*Plastics.* R. B. Seymour. Ind. Eng. Chem. *52*, 1038-42 (Dec. 1960). Recent developments in plastics as materials of construction are reviewed.

## Materials

*New blowing agents for foaming plastics.* R. A. Reed. Brit. Plastics *33*, 468-72 (Oct. 1960). The potentials of a number of newer blowing agents for foamed plastics are examined. Most of these materials are organic compounds that decompose to yield nitrogen. They are compared with compounds already established in this particular field.

*Porous plastic laminates.* J. T. Hill, E. de Vries, and F. Leonard. SPE J. *16*, 1047-51 (Sept. 1960). A method has been devised for producing porous laminates of fabric and epoxy resins. The mechanical properties and rate of flow of water were determined on various laminates. Important considerations affecting laminate porosity are the concentration of diluent, the boiling point of diluent relative to the final cure temperature, the pre-cure time, and the ambient temperature as well as the humidity.

*A survey of encapsulating systems.* E. Schatz. Product Eng. *31*, 68-74 (Sept. 19, 1960). An introduction to the technology of encapsulation and an up-to-date comparison of the basic systems are given.

## Molding and fabricating

*Coloring linear polyethylene,* P. E. Campbell, R. J. Martinovitch, and T. V. Gay. SPE J. *16*, 1052-55 (Sept. 1960). Methods of coloring polyethylene and the variables requiring control in both injection and extrusion molding are discussed. Three screening tests were devised to evaluate coloring agents. These include stability to heat at 500° F. for 30 min.; resistance to ultra-violet fading after 200 hr. in the Atlas Fadeometer; and color migration into filter paper and plasticized polyvinyl chloride after 72 hr. at 50° C.

## Applications

*Detergents spur plastic container output.* Chem. Eng. News *38*, 32 (Nov. 14, 1960). Data on plastics container output are presented. A total production of 2 to 3 billion units per year is predicted for 1965, more than doubling the 1960 production.

*Sprayed metallic and plastic coatings.* J. H. Nicholls. Corrosion Tech. *7*, 275-79 (Sept. 1960). A number of plastics are suitable for use as sprayed coatings for corrosion prevention. These include polyethylene, polysulfide, the superpolyamides, polytetrafluoroethylene, and polytrifluorochloroethylene. The performance of these plastics coatings are compared with those of sprayed metal coatings.

## Properties

*Flexural and impact variations of phenolic moldings: A statistical round-robin study.* C. Elmer and E. C. Harrington Jr. ASTM Bulletin No. 249, 35-38 (Oct. 1960). The results of a round-robin study on the flexural and impact properties of molded phenolic plastics indicate that there are variations caused by interlaboratory techniques, equipment, and specimen preparation. The flexural strength of transfer-molded specimens was about 13% higher than that of compression-molded specimens with a standard deviation of 5.5% for both groups. A molding temperature increase from 290 to 350° F. caused a 12% increase in this strength. The impact strength of compression-molded specimens was about 14% higher than that of transfer-molded specimens with variations depending on the end of the molded bar from which the specimen was taken.

*Wetting properties of tetrafluoroethylene and hexafluoropropylene copolymers.* M. K. Bernett and W. A. Zisman. J. Phys. Chem. *64*, 1292-94 (Sept. 1960). Wettability is a function of the nature and physical packing of the atoms in the surface and is essentially independent of the nature and arrangement of the underlying atoms and molecules. Polytetrafluoroethylene (PTFE) has the lowest surface energy and thus the lowest critical surface tension of wetting of all organic polymers. The wettability of a series of copolymers of TFE with hexafluoropropylene by organic and inorganic liquids was studied. These solid plastics have critical surface tensions which are even lower than that of solid PTFE. Progressive increase in the proportion of perfluoromethyl side chains in the polymer introduces a higher concentration of exposed $-CF_3$ groups in the surface which reduces the critical surface tension of wetting.

*Effect of water on the bursting strength of rigid PVC pipes.* A. K. van der Vegt. Kunststoffe *50*, 537-40 (Oct. 1960). Moisture absorption and creep strength curves were determined for a number of rigid PVC pipes at 60° C. The effects of previous storage in water on bursting strength at different temperatures and for different periods were investigated. The moisture absorption cannot be taken as a criterion for the behavior of the pipe.

## Testing

*Study of wettability of polymers by sliding of water drop.* K. Kawasaki. J. Colloid Sci. *15*, 402-407 (Oct. 1960). The sliding of water drops down tilted polymer slides was studied to obtain information on wettability of some polymers. The angle of sliding, at which the drop moves at a uniform rate was taken as a measure of the wettability of the surface. The equations for the calculations are given and data tabulated for nine polymers. An equation that takes into account the roughness of the solid surface is also given.

## Publishers' addresses

**A.S.T.M. Bulletin:** American Society of Testing Materials, 1916 Race St., Philadelphia, Pa.

**British Plastics:** Iliffe and Sons Ltd., Dorset House, Stamford St., London SE1, England.

**Chemical and Engineering News:** American Chemical Society, 1155 Sixteenth St., N. W., Washington, D. C.

**Corrosion Technology:** Stratford House, 9 Eden St., London NW1, England.

**Industrial and Engineering Chemistry:** American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

**Journal of Colloid Science:** Academic Press Inc., 125 E. 23rd St., New York, N. Y.

**Journal of Physical Chemistry:** American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

**Kunststoffe:** Karl Hanser Verlag, Leonard-Eck-Str. 7, Munich 27, Germany.

**Plastics (London):** Temple Press Ltd., Bowling Greene Lane, London EC1, England.

**Product Engineering:** McGraw-Hill Publishing Co., 330 W. 42nd St., New York 36, N. Y.

**SPE Journal:** Society of Plastics Engineers Inc., 65 Prospect St., Stamford, Conn.—End

*Reg. U.S. Pat. Off.

# U.S. PLASTICS PATENTS

**Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 25¢ each.**

### U.S. Pats., Oct. 18, 1960

*Cellulose ester plastics.* M. Salo, G. J. Clarke, C. J. Kibler, and J. W. Tamblyn (to Eastman Kodak). 2,956,-895-6.

*Graft polymers.* E. T. Cline (to Du Pont). 2,956,899.

*Epoxy compounds.* C. V. Detter (to Phillips). 2,956,959.

*Polystyrene composition.* S. P. Nemphos (to Monsanto). 2,956,960.

*Polyurethanes.* C. J. Kibler, A. Bell, and J. G. Smith (to Eastman Kodak). 2,956,961.

*Polycarbamate-aldehyde resins.* R. M. Christenson and N. A. Jacobson (to Pittsburgh Plate Glass). 2,956,964.

*Plasticized phenolic resins.* R. Steckler (to General Aniline). 2,956,965-6-7.

*Polyamide resins.* G. Swann and P. G. Evans (to Beck Keller). 2,956,968.

*Vinylidene chloride copolymers.* C. B. Havens (to Dow). 2,956,969.

*Plasticizers.* J. R. Caldwell and W. J. Jackson Jr. (to Eastman Kodak) 2,956,977-8.

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*Plasticizers.* J. R. Caldwell and W. J. Jackson Jr. (to Eastman Kodak). 2,-956,987.

### U.S. Pats., Oct. 25, 1960

*Hollow bodies.* S. H. Magid. 2,957,-792.

*Laminating polyurethane foam.* J. W. Dickey (to Curtiss-Wright). 2,957,-793.

*Polyurethane foams.* E. E. Parker (to Pittsburgh Plate Glass). 2,957,831.

*Cellular polyurethane.* G. T. Gmitter and E. M. Maxey (to General Tire). 2,957,832.

*Styrene composition.* S. J. Baum (to Foster Grant). 2,957,833.

*Aminoplasts.* H. M. Culbertson and B. L. Williams (to Monsanto). 2,-957,835-6.

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*Polythiourea-polyepoxide co-cured.* G. L. Wesp (to Monsanto). 2,957,-844-5-6.

*Polypropylene.* R. M. Kennedy (to Sun). 2,957,849.

*Substituted benzene-formaldehyde resins.* L. C. Fetterly (to Shell). 2,957,-851.

*Terpolymer systems.* E. C. Chapin and R. F. Smith (to Monsanto). 2,-957,853.

*Vinylpyridine copolymers.* L. E. Lorensen, J. Zachar and R. C. Jones (to Shell). 2,957,854.

*Phosphorus-containing resins.* H. R. Guest and B. W. Kiff (to Union Carbide). 2,957,856.

### U.S. Pats., Nov. 1, 1960

*Propellant liner.* W. E. Campbell Jr. and L. H. Brown (to Aerojet). 2,-958,288.

*Cellulose ether compositions.* F. E. Windover, S. M. Rodgers Jr., and G. H. Beaver (to Dow). 2,958,607.

*Reinforced structure.* A. B. Freeman, B. D. Raffel, and R. A. Tripp (to Goodyear). 2,958,621.

*Vinyl chloride-dialkyl maleate copolymer.* C. I. Carr Jr. and G. C. Zwick (to U. S. Rubber). 2,958,668.

*Copolymers.* H. Keskkula, R. M. Price, and A. F. Roche (to Dow). 2,958,671.

*Graft polymer.* Y. Jen (to American Cyanamid). 2,958,673.

*Naphthalene-formaldehyde.* H. Krzikalla and F. van Trakranen (to Badische Anilin). 2,958,676.

*Polyamides.* R. F. Kleinschmidt (to Phillips). 2,958,677.

*Crosslinked copolymers.* J. F. Jones (to Goodrich). 2,958,679.

*Polyallyl-trimethylsilane.* T. W. Campbell (to Du Pont). 2,958,681.

*Polybetaine.* W. H. Schuller and D. C. Guth (to American Cyanamid). 2,-958,682.

*Octafluorocyclohexa-1,3-diene polymers.* W. Hopkin and A. K. Barbour (to National Smelting). 2,958,683.

*Perfluoropropylene polymers.* H. S. Eleuterio (to Du Pont). 2,958,685.

*Isotactic polystyrene.* K. R. Dunham, J. Van Den Berghe, and W. J. Dulmadge (to Eastman Kodak). 2,958,-686-7.

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*Sound absorbing system.* R. Muller, U. Fritze, and H. W. Paffrath (to Bayer and Mobay). 2,959,242.

*Expanded thermoplastic.* D. L. Graham, R. N. Kennedy, and E. L. Kropscott (to Dow). 2,959,508.

*Irradiated epoxy compounds.* C. E. Wheelock (to Phillips). 2,959,531.

*Modified urea resins.* H. M. Culbertson and F. J. Hahn (to Monsanto). 2,959,558.

*Polyesters.* H. Delius (to Reichhold). 2,959,559.

*Chlorinated polyethylene.* H. Klug (to Lucius & Bruning). 2,959,562.

*Polyester-diallyl isophthalate resins.* G. A. Cypher and M. Cohen (to General Electric). 2,959,564.

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*Epoxide resins.* G. Faerber (to Deutsche Solvay). 2,959,571.

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*Copolymers of pentafluorobutadiene.* E. S. Lo (to 3M). 2,959,575.

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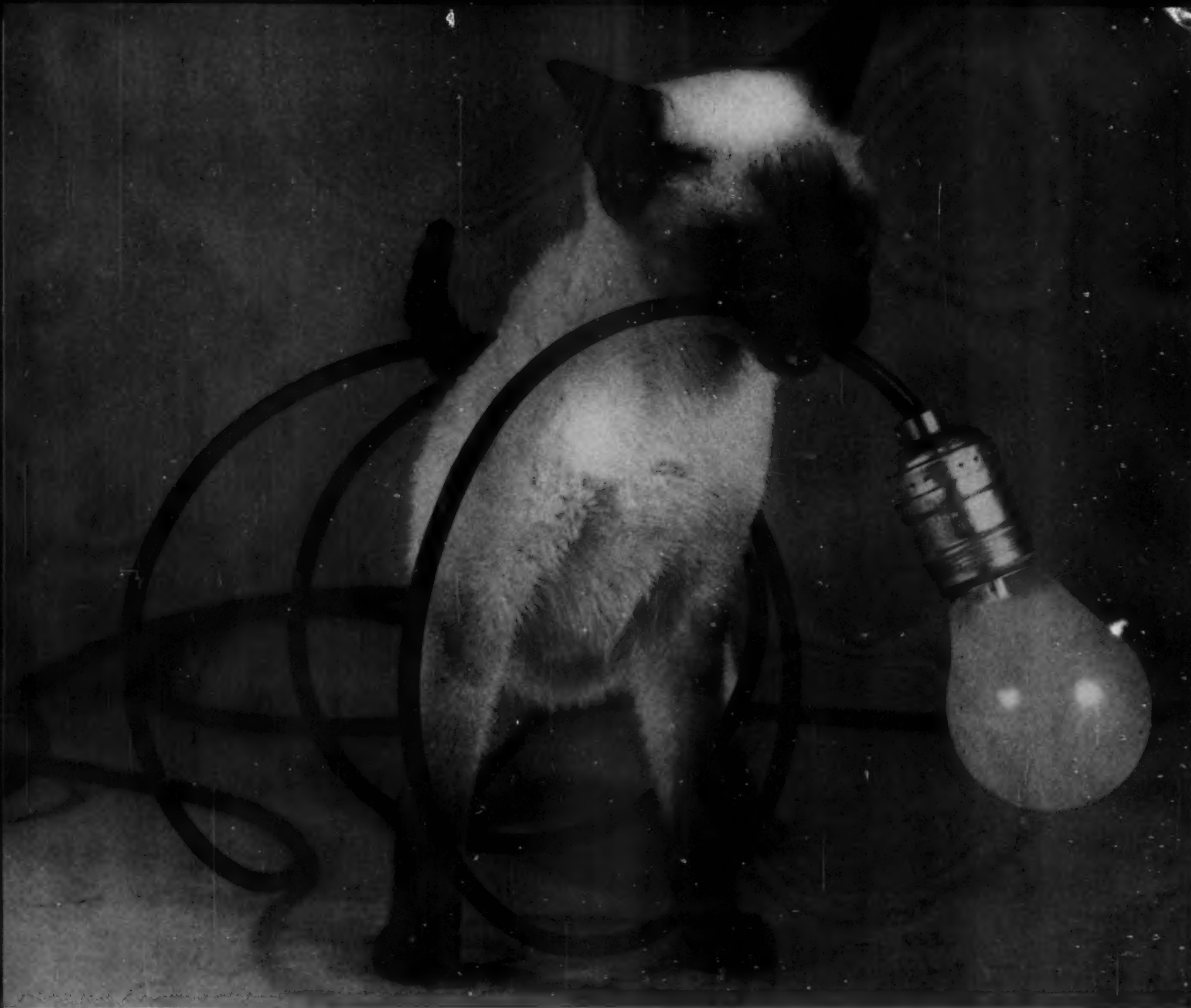


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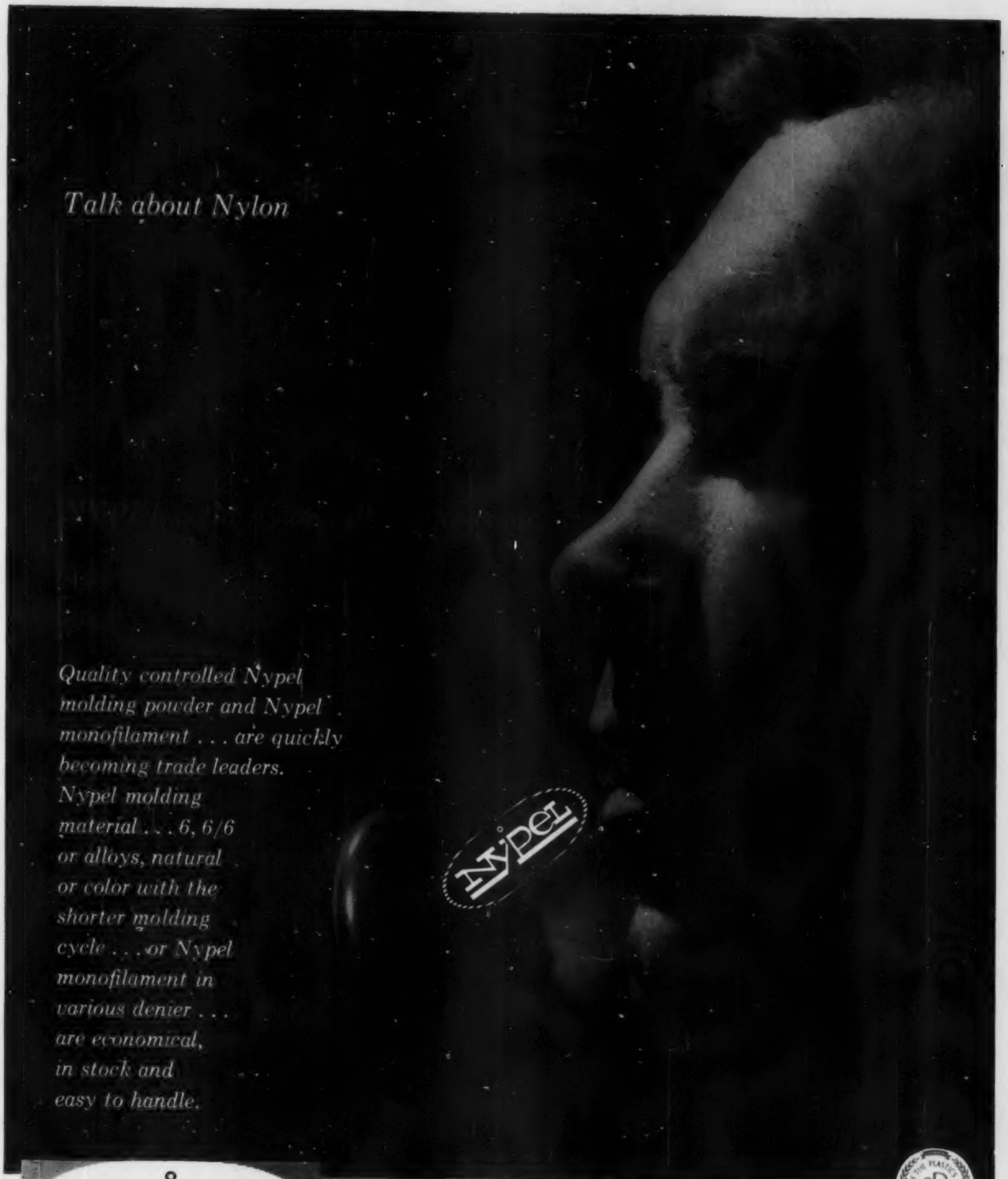
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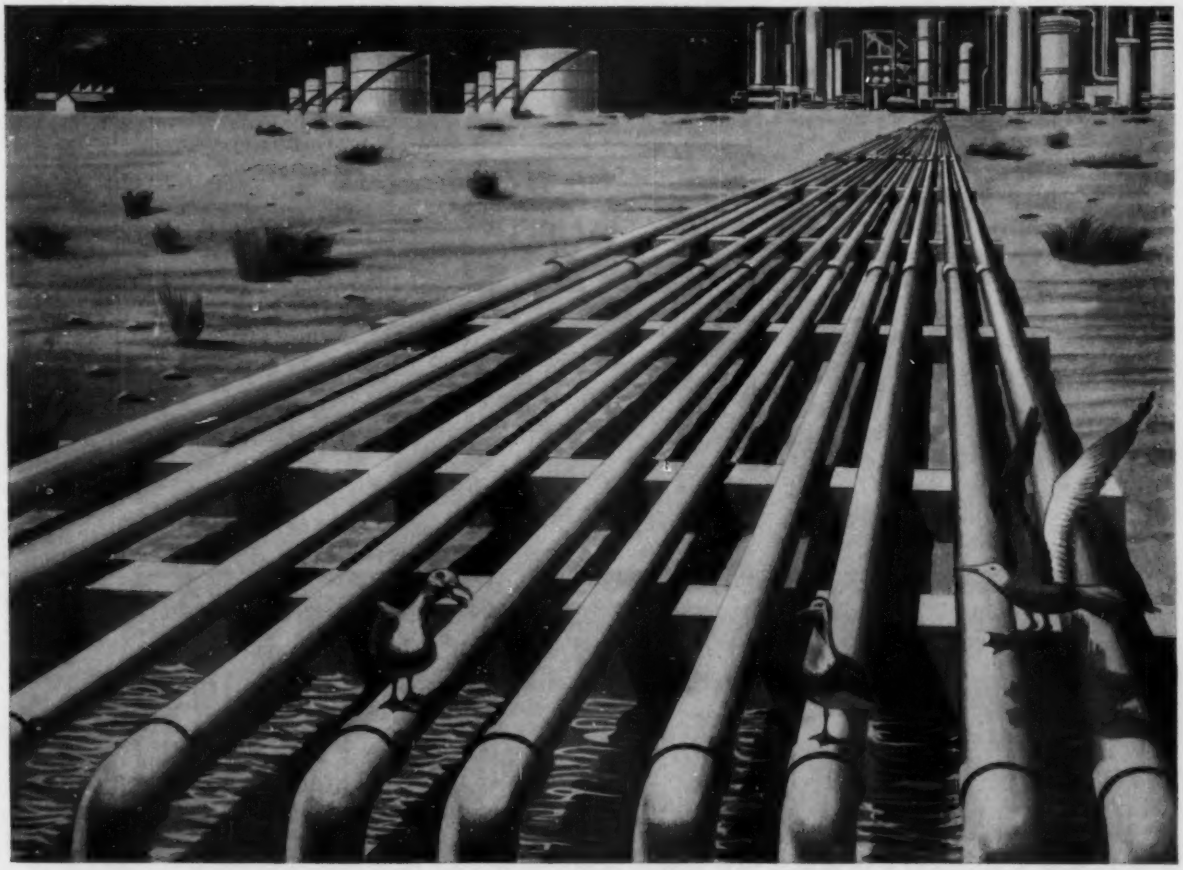

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# MODERN PLASTICS

## MAY 1961–NATIONAL PLASTICS "SHOW ISSUE"

**WIDEST READERSHIP EVER!**

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While still unofficial, January's issue of MODERN PLASTICS Magazine with more than 35,000 paid circulation, represents an estimated 12-month gain of close to 3,000. Proof again of MODERN PLASTIC's editorial vitality and the volatile nature of this growing market.

### Provides complete information

on the one and only 9th NATIONAL PLASTICS EXPOSITION, June 5-9, 1961 sponsored by The Society of the Plastics Industry at the New York Coliseum and co-featuring The SPI National Conference at the Hotel Commodore during the week of the Show.

MODERN PLASTICS' "Show Issue" will carry a complete guide to the show, including a giant-size diagrammatic layout of the exhibit areas, full schedule of meetings and special activities, program of the Plastics Conference and other news.

### Two-Continent Coverage

In addition to covering the National Plastics Exposition in the United States, MODERN PLASTICS will provide extra readership through its presentation of detailed information on the

BRITISH PLASTICS SHOW, June 21—July 1 at the Olympia, London, England and the

EURO PLASTICA EXPOSITION, June 16-25 at the Palais de Floralies, Ghent, Belgium

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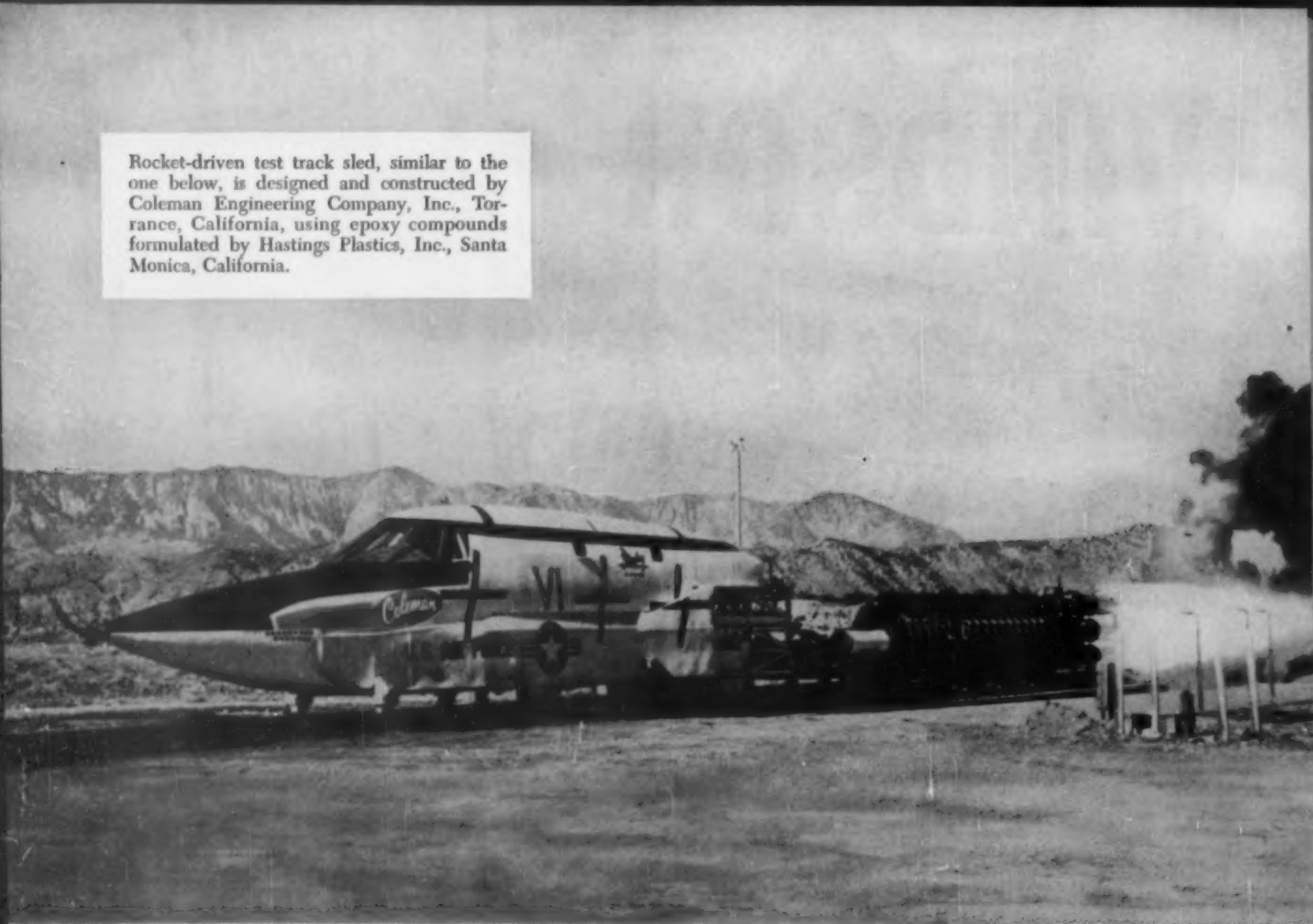


Rocket-driven test track sled, similar to the one below, is designed and constructed by Coleman Engineering Company, Inc., Torrance, California, using epoxy compounds formulated by Hastings Plastics, Inc., Santa Monica, California.

# Epoxies Pass the Test

## AT SUPERSONIC SPEEDS

Rocket propelled, test sleds at the Hurricane Supersonic Research Site travel faster than Mach I, providing performance data on components for future supersonic vehicles. To meet such working conditions and keep cost, weight, and tooling at a minimum, these vehicles and nose cones are constructed of glass cloth laminated with epoxy compounds based on BAKELITE Brand epoxy resins.

Epoxies offer multiple advantages to fabricators of reinforced plastics. Epoxy-glass cloth laminates have excellent fatigue resistance, very high strength-to-weight ratios, and a very low coefficient of expansion. The extremely versatile nature of BAKELITE epoxy resins leads to their widespread use in coatings, adhesives, and casting and potting materials.

For the latest information on how BAKELITE Brand epoxy resins can meet your production and performance requirements, talk to your Union Carbide Technical Representative. Or write Dept. JM-87B, Union Carbide Plastics Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

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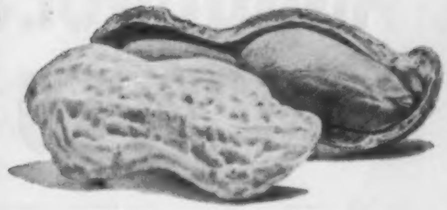

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New product information for fiber glass reinforced plastics industry

# fiber glass news

PPG fiber glass makes products better, safer, stronger, lighter

FEBRUARY, 1961

# PPG ANNOUNCES NEW FIBER GLASS CHOPPED STRAND MAT

## PPG Customers Praise New Reinforcing Mat

Samples of the first runs of the new PPG Chopped Strand Mat were shipped to several PPG customers for use in production trials.

These customers obtained excellent results. One panel manufacturer reported the new product helped him produce highly translucent corrugated sheets with the fiber pattern almost indistinguishable. Wet-out characteristics were superior to other products he had tried. Based on these trials, he has placed a sizeable reorder.

Similar reports have been received from other manufacturers.

## PPG Offers Technical Help to Manufacturers

Samples of PPG's new Chopped Strand Mat are available to manufacturers for trial runs on their own equipment.

If you need technical assistance on these runs, a member of PPG's technical staff will be glad to answer any questions you may have concerning the use of this new product. If you wish, he will come to your plant to help run tests, demonstrate techniques and help adjust machinery settings to obtain best results.

## Quality Product for Sheets, Boats, High Pressure Molding

Now available from PPG is a new high quality fiber glass reinforcing Mat.

Produced from PPG's new chopped strand with a specially developed binder, this new mat has excellent wet-out characteristics, provides highly uniform fiber distribution and weight; and because it produces a pure whiteness, it eliminates any problem of discoloration of finished laminates.

### Three Types Available

Type AC Mat has been designed especially for corrugated, embossed or flat translucent fiber glass decorative and structural panels where clarity and lack of fiber pattern is important.

Type AB Mat is ideal for boat manufacturing and other layup jobs where strength, good draping and fast wet-out are needed.

Type AM Mat is available for use in high pressure molding to produce strong, uniform finished products.

## New Mat Produced In Complete Size Range

PPG Chopped Strand Mat is produced in widths and weights to meet your specifications.

Announced weights per square foot in ounces are ¾, 1, 1¼, 1½, 2 and 3. Width range includes 40", 56", 60" and 76". Other widths are available by special order.

Mats are packaged wound on 4" I.D. tubes according to width dimensions.

## Literature Available

Complete information on PPG Fiber Glass Chopped Strand Mat is available through any of the PPG Fiber Glass Sales Offices listed below, or by writing PPG Fiber Glass Division direct. Get your copy now, and learn how you can benefit from this new mat product.

## Where to Buy It

PPG Fiber Glass Chopped Strand Mat can be ordered through any PPG Fiber Glass Sales Office or regional distributor, or can be ordered direct by writing or calling *Pittsburgh Plate Glass Company, Fiber Glass Division, Room 1662, One Gateway Center, Pittsburgh 22, Pennsylvania.*

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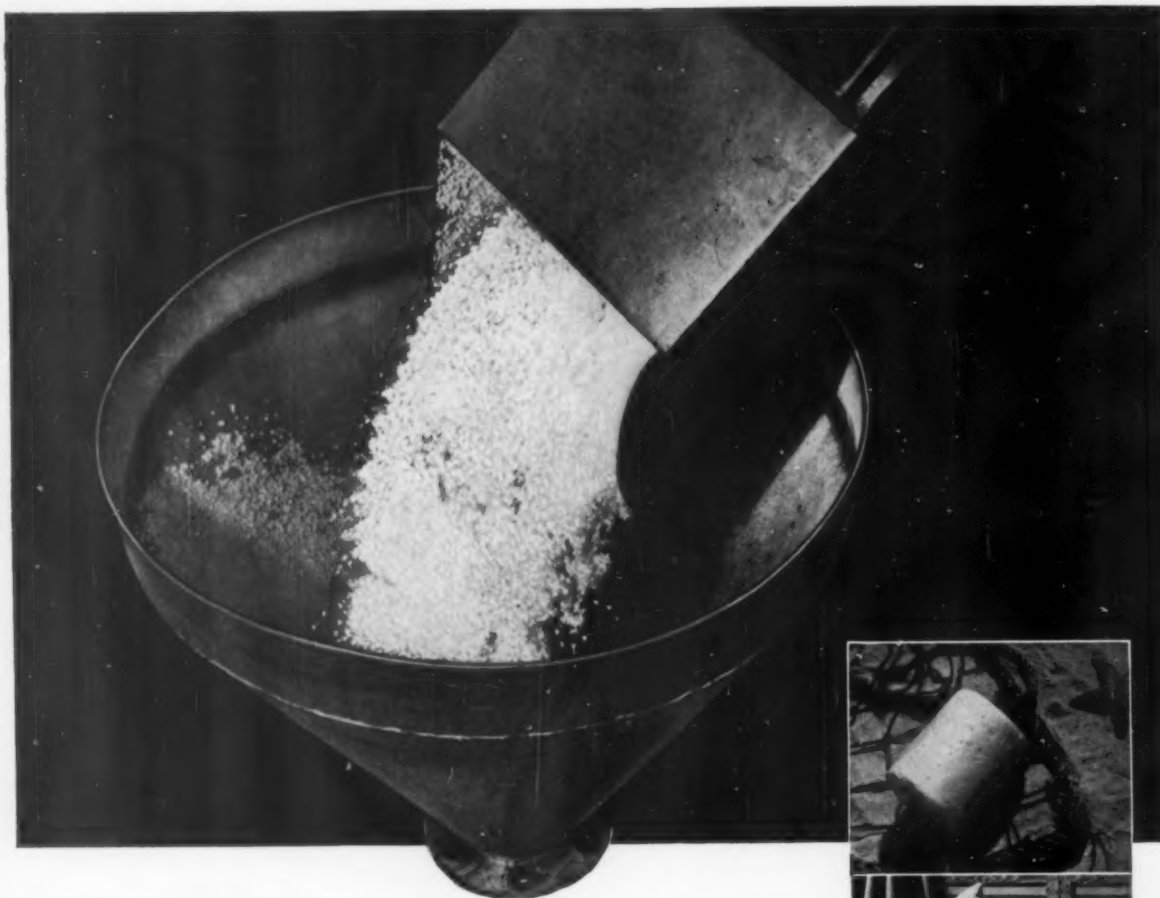

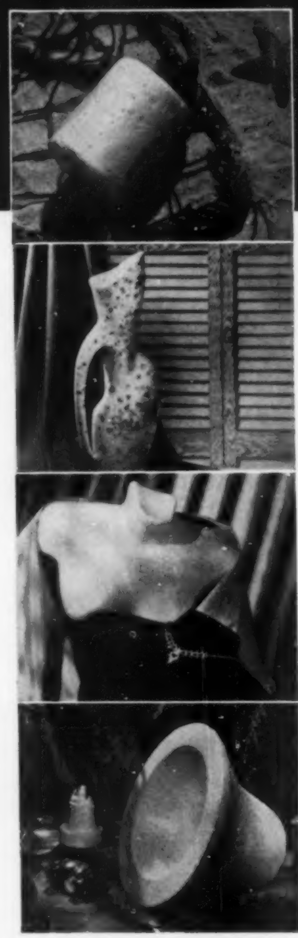

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*Standard engineers designed the Automolder 100 ton 3 ounce injection molding machine to meet the needs of the plastic industry. Full hydraulic clamp assures faster mold set-up . . . full range electrical controls save operator time . . . compact design with self contained hydraulic system occupies less space. The K3-100-50 is the first of 5 new Automolders to be introduced during our Golden Anniversary.*

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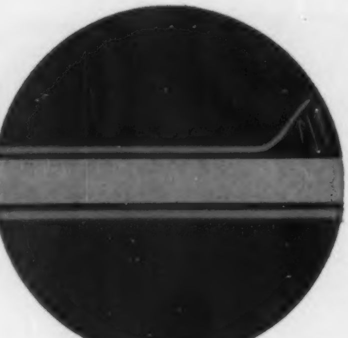

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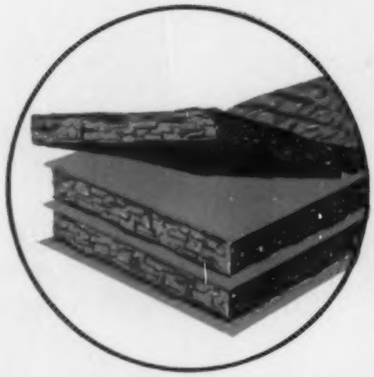

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# U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

## Packaging Notes

**High-speed bottle blowing machine** available from a Danish firm produces 5,000 finished bottles per hour, according to a recent announcement. Fully automatic, it operates with 1 to 5 molds, can work on 11 different cycles, has 3 interchangeable tables (up to ⅛, 2½ and 5 gallons).

**Squeezable ink bottle** blow-molded of conventional polyethylene permits tidier filling of fountain pens. Pressing the sides of the bottle draws ink into a special well from which pen is easily filled.

**Extra-length heat sealer** designed for use with thin polyethylene films makes seals up to 96" long. The latest of a series of heavy-duty, all-steel thermal units available from a New York company, it operates by foot switch and has a pneumatic safety system. Can be adapted with built-in "recycler" for automatic operation and completely controlled integral compressed air supply.

**Polyethylene filling cover** for drums and tanks has cavity to catch dangerous and costly spillage. It has built-in handles, expandable fill pipe opening and molded pouring lip. And, according to the producer, is chemical resistant, lightweight and unbreakable.

**New moisture-tight bags,** designed for highly hygroscopic products, are constructed of strong white paper laminated to aluminum foil with polyethylene coating on the foil side. All seams are heat-sealed, as is the top after filling.

A California company chose these bags over cans of comparable capacity for its instant apple sauce. Extensive testing showed they resist moisture and retain vitamins; cost 48% less than cans, take 23% less space and weigh 10% less. The product is being packaged semi-automatically in 19 oz. and 7-lb. bags flexographically-printed in red, green and yellow.

## Polyethylene Mulch Film Permits Early Crop Set and Harvest . . . Ups Marketable Yields

### Increases Test Yields of Vegetables As Much As 100%

Recent tests at the Oregon State College Agricultural Experiment Station, Corvallis, and the South Dakota State College Agricultural Experiment Station, Brookings, have proved that polyethylene mulch film more than justifies its cost.

See the difference polyethylene mulch film can make? The plant at left was grown with film, the one at right without. Note healthier look, greater yield.

Findings were cited by James P. Menn, staff agronomist of the U.S. Industrial Chemicals Co., at the 73rd Annual Meeting of the Florida Horticultural Society.

Mr. Menn noted that the Oregon State College tests on tomatoes resulted in a marketable yield of over 20 tons per acre with polyethylene mulch, 10 tons per acre without. Marketable pole bean and cantaloupe yields also were considerably greater when the mulch was used. At South Dakota State College, too, significant yield increases were reported for sweet corn, snap beans, carrots, cabbage, and cucumbers.

Available commercially in durable, flexible, lightweight black film, polyethylene mulch provides special protection because of its high impermeability to water vapor and gases. Its physical properties can be varied to raise or lower soil temperatures, conserve soil moisture and control weeds and plant diseases. Consequently, it often results in early crop set and harvest as well as increased marketable yields.

The U.S.I. agronomist pointed out that some 33 land grant colleges are now carrying on, or have recently completed, research projects on polyethylene and other plastic mulch materials.

## New Connector For Polyethylene Tubing

A new kind of fitting, claimed to connect small-diameter polyethylene tubing simply and economically in just two seconds, has been introduced. According to the manufacturer, the new connector will open up possibilities of replacing metal tubing with lower-cost polyethylene tubing in electrical appliances, automotive equipment and other industrial applications.

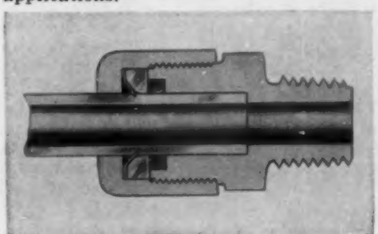

Photo courtesy D & G Plastics Co.

The fitting is an O.D. type, so there is no restriction to flow. Connection is made by merely inserting tube into the fitting with a twisting motion as far as it will go. Result is a positive seal—leakproof for vacuum, gases and fluids over a wide range of temperatures and pressures.

Connectors are guaranteed by the manufacturer to meet all requirements governing the transmission of fluids for human consumption. Available for use with standard tubing ¼", ⅜", ½" and ⅝"—either male or female threads.

## Oil-Resistant Ink System For Polyethylene Film

Shredded coconut and other products high in vegetable oils can now be packaged in polyethylene film printed in as many as five colors. A new oil-resistant ink system, sold at no extra charge over regular ink systems, has been successfully tested on thousands of bags, its developer reports.

Previous ink formulations used on such oily products would soften or rub-off on nearby packages or customers' hands. Destructive tests on the new inks have shown no deterioration and have proved out shelf life and oil resistance. Special printing plates used are compatible with the inks.

**DO YOU HAVE a new polyethylene product or development you'd like the industry to know about? Make it routine to send your information on new developments to U.S.I. POLYETHYLENE NEWS.**

Address:
U.S.I. POLYETHYLENE NEWS, U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corp., 99 Park Avenue, New York 16, N. Y.

# NOW...VIRGIN FOR INJECTION 26¢/ DIRECT FROM

**U.S.I. Sets Record Low Price for Virgin PETROTHENE® Polyethylene Resins With Melt Index and Flow Properties Designed For Injection Molding Toys, Housewares, Novelties.**

There's no doubt that 26¢ is an attractive price for injection molding polyethylene resin. But it takes more than just a low price tag to make a bargain.

U.S.I.'s new PETROTHENE polyethylene resins are good buys at 26¢ because you get quality virgin injection molding resins with well-defined properties . . . you are dealing directly with the producer . . . and the producer – well-known and long-established – puts his reputation behind the resins.

**YOU GET QUALITY.** PETROTHENE 117 and 213 polyethylene are virgin resins developed exclusively for injection molding applications – housewares, toys, novelties.

PETROTHENE 117 produces moldings of good appearance, extreme toughness and high gloss. Molded items have a low to medium stiffness.

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**YOU GET VIRGIN RESINS.** PETROTHENE 117 and 213 polyethylene resins are pure, unreprocessed materials which you can purchase only from the manufacturer – U.S. Industrial Chemicals Co. Their properties, shown in the accompanying table, are clearly defined.

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U.S.I. has built its reputation for quality, reliability and service as a producer of chemicals and resins for over half a century. This reputation stands behind every shipment.

Series VI, No. 1

# POLYETHYLENE PROCESSING TIPS

## HOW TO DETERMINE OPTIMUM BLOW-UP RATIO

In blown film extrusion, blow-up ratio is the ratio of the diameter of the film "bubble" to the diameter of the extruder die. It's much easier to measure the width of the lay-flat tube after it has passed through the nip rolls than the diameter of the inflated bubble. And since the two are related by simple geometry, blow-up ratio can be calculated easily from the formula:

$$\text{Blow-up ratio} = 0.637 \times \frac{\text{lay-flat width}}{\text{die diameter}}$$

The best possible balance of film properties for a given polyethylene resin can be obtained with a 2:1 to 2.5:1 blow-up ratio. This recommendation is based on studies at U.S.I.'s Polymer Service Laboratories, combined with field experience of U.S.I.'s Technical Service Engineers.

### Effect on Specific Film Properties

In the U.S.I. studies, six general-purpose film-grade polyethylene resins were extruded under comparable conditions at blow-up ratios of 1:1, 1.5:1, 2:1, 2.5:1, 3:1, and 3.5:1. The properties of these resins varied over a rather wide range. Yet, as blow-up ratio was increased, the effect on specific properties was similar for all six resins:

**Transmittance** increased 12 to 16 units (Fig. 1). PETROTHENE® 112, for example, had a 60% transmittance at 1:1 blow-up ratio and 72% transmittance at 3.5:1.

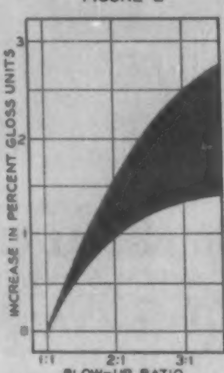
**Gloss**, measured at a 60° angle, increased 1.2 to 2.5 units (Fig. 2). The average was 7.1% at 1:1 blow-up ratio and 9.3% at 3:1.

**Haze** decreased significantly (Fig. 3). Average decrease was 3.5 to 4.5 units.

**Impact strength** improved (Fig. 4).

FIGURE 1


FIGURE 2




While these tests seem to indicate 3:1 or higher as an optimum blow-up ratio, this is not the case. Note how other essential properties are affected by an increase in blow-up ratio:

**Straight line tear**, the tendency of film to tear in a straight line, is reduced significantly.

**Elmendorf tear strength** decreases significantly above a 2:1 blow-up ratio.

**Yield strength** decreases slightly.

**Break point** increases in the transverse direction and decreases in the machine direction.

**Tendency to wrinkle** may be a serious problem above a 2.5:1 blow-up ratio.

### How To Increase Blow-Up Ratio

Because film lay-flat width is almost always predetermined, blow-up ratio is ordinarily increased by using a smaller die diameter. True, this results in a slight decrease in output; however, increasing screw speed will usually compensate for most of this decrease.

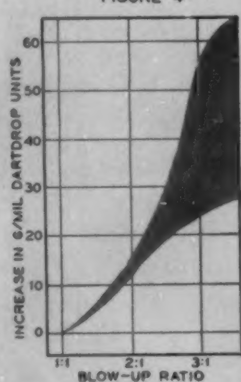
### What Blow-Up Ratio Should You Use?

Extruders now producing blown film at a blow-up ratio below 2:1 should consider increasing it if they desire improved optical properties and higher impact strength. Also, companies entering the field should consider blow-up ratio before deciding which size dies to buy.

Of course, other factors may be involved. If you have questions on specific problems, we suggest you seek advice from U.S.I. Technical Service Engineers.

FIGURE 3


FIGURE 4

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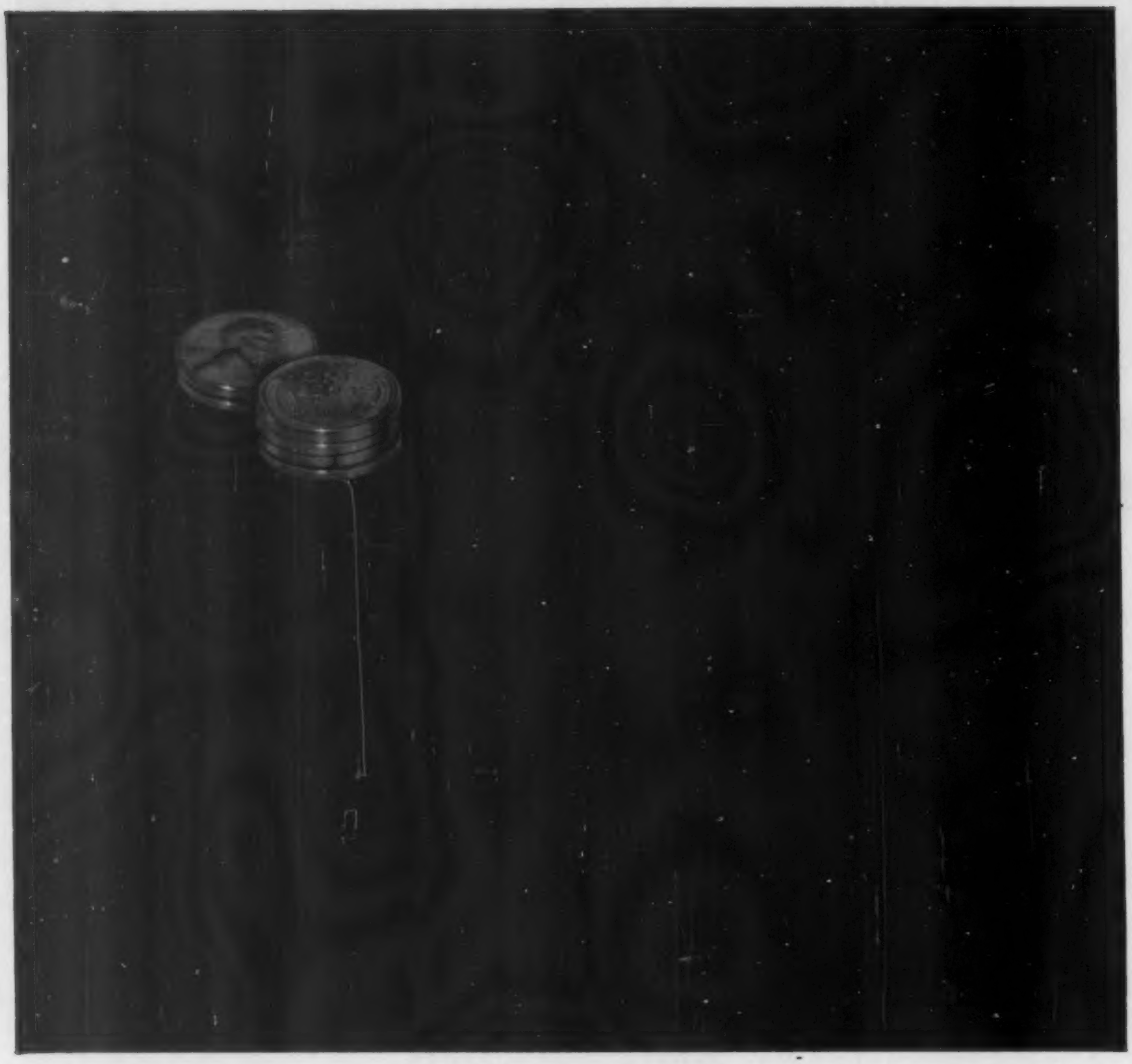

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Why? Because these few additional pennies buy a proven low-temperature winner . . . Plastolein 9058 DOZ. We'll admit that cheaper low-temperature plasticizers appear tempting. But do they warrant putting the future of your business in jeopardy?

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**MODERN PLASTICS**

**February 1961 Volume 38, Number 6**

**EDITORIAL COMMENT**

# The price is NOT right!

Year-end business reviews in newspapers and general magazines carried headlines saying "Prospects for 1961—upswing in second half."

Oh, happy second half!

Upswing in what? In volume? In employment? In profits? In prices?

If there is no basic improvement in the price behavior of the plastics industry in 1961 as compared to 1960, no matter how high sales volume goes, profits will be pitiful.

The price of vinyl dropped from 30¢/lb. to 18½¢ in three years. Polyethylene dropped from 35¢ in 1957 to 27½¢ (more or less) now. Polystyrene dropped from 25¢ to 18¼¢ in the same period. And beneath the listed prices there is always wheeling and dealing in costly pennies.

These price drops cost the plastics industry at least an estimated $50,000,000 in these three years. The profits on this dollar volume disappeared—profits that could have been used for research, market development, promotion, and construction of new plants to replace obsolete ones.

The life of a resin or compound, from laboratory conception through production and application to obsolescence, historically has been between 5 and 7 years. Without reasonable profits, how shall we get new materials?

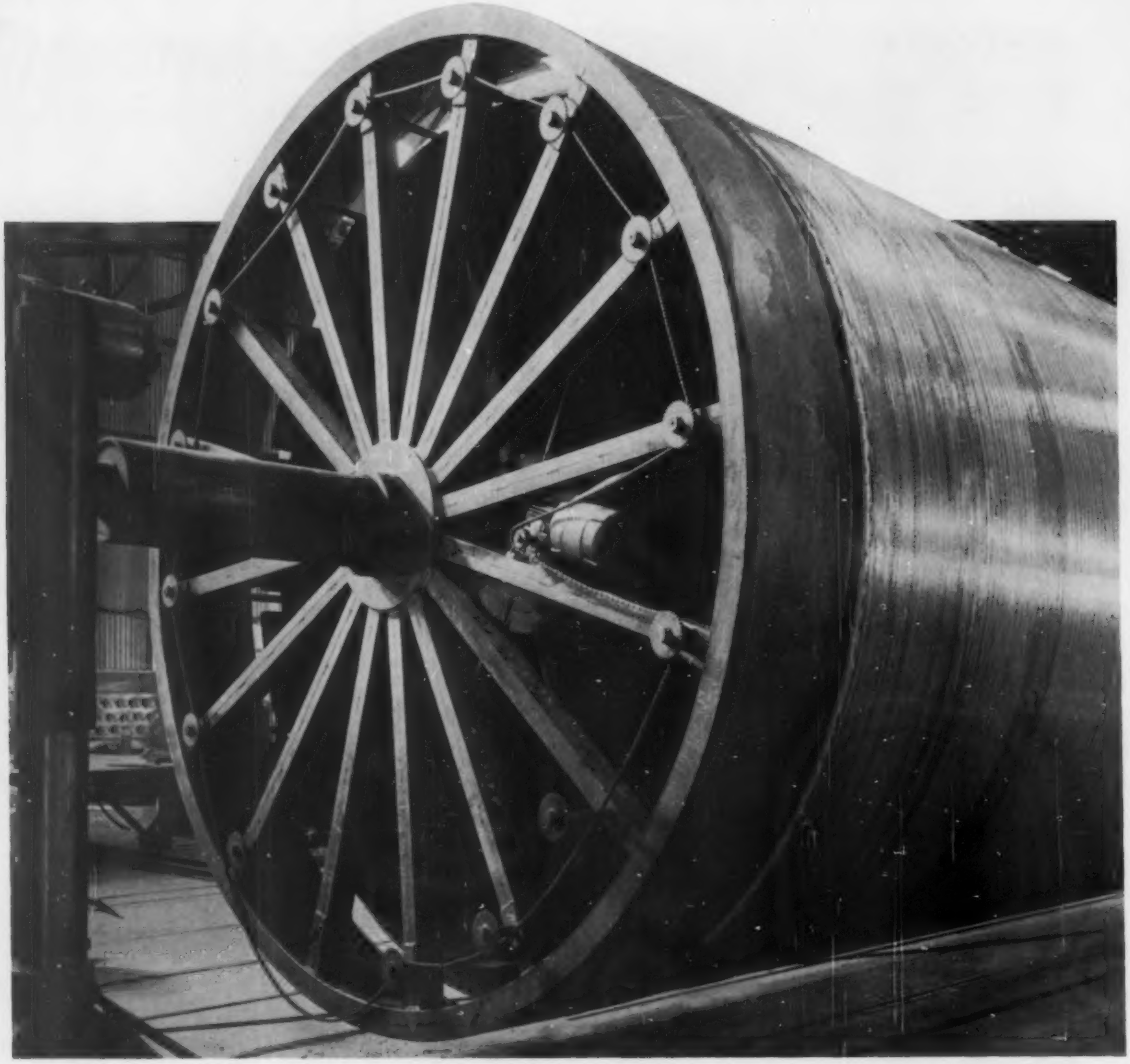
Admittedly while metals and other non-plastics materials have been going up in price or have held prices firm, and the prices of plastics have been going down, some applications have switched to plastics; and even more have switched from one plastic to another. But price was not the whole reason in either case.

The main reason was the development work done to improve plastics, the engineering and design services offered. Without sound profits how can this work continue?

We're all for an upswing in any part of 1961. Let's start with an upswing in prices! And let's be realistic about it.

Hiram McCann

Modern Plastics Executive and Editorial Offices: 575 Madison Avenue, New York 22, N.Y. Tel.: PLaza 9-2710; TWX: NY 1-3063; Cable address: BRESKINPUB.



## CASE STUDY #1.—*Largest filament-wound tank*

Those manufacturers who have found a perfect solution to some of their more pressing corrosion and maintenance problems in the use of reinforced plastics industrial equipment laid a whopping 7½ million dollars on the line in 1960 to justify their faith in the material. For a market whose total dollar value five years ago was probably in the low thousands, this is not only good growth—it's fantastic!

Reinforced plastics are no longer specialty materials for specialty applications; in industry's eyes, they have finally achieved the status of standard materials of construction on a par with metals and woods. And reinforced plastics are no longer limited to simple piping and ducting systems. Today, the sky's the limit: fume stacks that rise 200 ft. in the air, storage and processing tanks with capacities up to 20,000 gal., fan housings that stand 11½ ft. high. And there are more exciting applications to come!

### *Economics—plus function*

Reasons for the upsurge in industrial use of reinforced plastics are not difficult to find. In terms of corrosion-resistance alone, they offer a degree of versatility that conventional materials find themselves hard-pressed to match. For potential industrial users, here's a benchmark as to how effective this resistance is: In a metallurgical refining operation involving hydrochloric acid fumes, unlined steel ducting lasted less than 1 week, metal alloys did a little better and lasted for a little over a month, rubber linings extended the service life to six months, and then came re-

**Better combinations of resins and reinforcements, new molding and assembly techniques, new engineering give us now**

# GIANT PLASTICS STRUCTURES

**MEASURING** 20 ft. in length and 12 ft. in diameter, storage and shipping tank is claimed to be the largest filament-wound commercial structure. Tank, which weighs about 1500 lb., is made by winding epoxy-saturated glass filaments over a rotating steel mandrel.

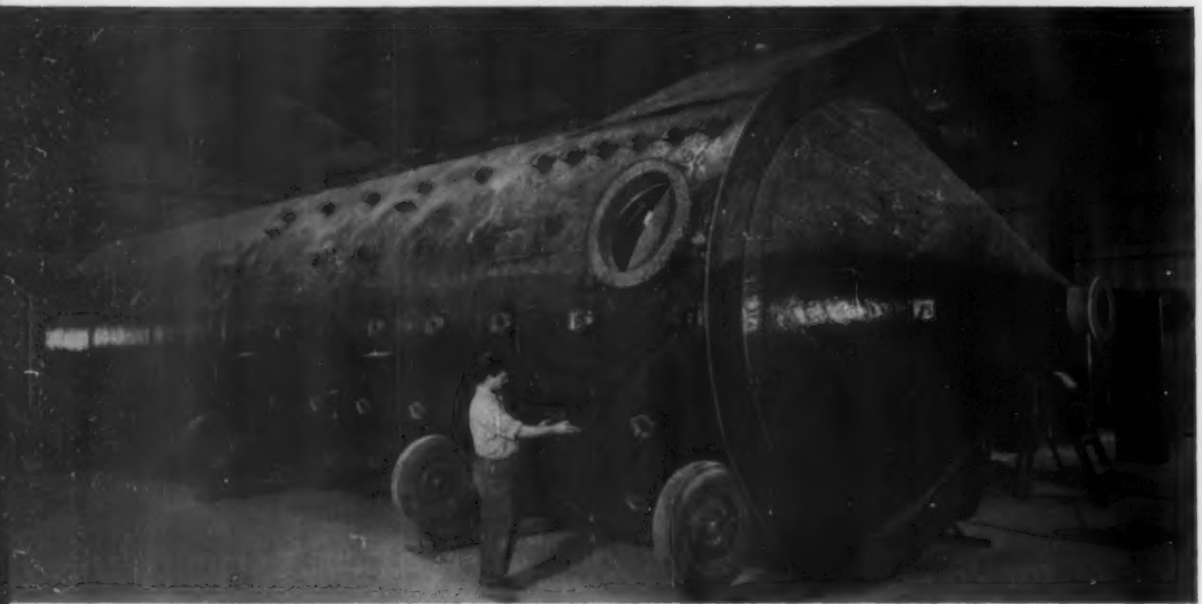
inforced plastics—still intact and operative after three years of service!

When corrosion resistance is stacked up against the economics of the reinforced plastics structures, the picture becomes even more inviting. In some of the smaller size units, initial costs are considerably lower than they would be in metal. Let's take a 1000-gal. tank as an example. Representative figures indicate that a tank of this size in reinforced plastics can be had, completely installed, for $800. Contrast this with a stainless steel tank that would be installed for a minimum of $2000.

In larger sizes, of course, the margin dwindles and initial costs of a reinforced plastics structure may be the same or even slightly more than metallic structures. But here the more indirect factors take over—lighter weight, minimal maintenance requirements, easier installation and repair. And when all these factors are totalled up, plastics are the odds-on favorite to wind up as the lower-cost product. In more specific terms, here is how these hidden cost factors would break down:

1) As a rule-of-thumb, reinforced plastics structures for industry weigh from 35 to 40% less than metal or wood. For standing units, *e.g.* fume stacks, lighter weight means simpler, less costly supporting construction. For transportation or shipping tanks, the economics are even more pronounced. One manufacturer offers this critique: by going to reinforced plastics for a trailer tank, he traded in his 3000-gal.-capacity rubber-lined steel tank for a 3400-gal. RP tank of equivalent gross weight. With the extra 400-gal. capacity thus

## CASE STUDY #2—*Fume scrubber... 47 ft. high*



**MAIN SHELL** of fume scrubber is molded in one piece by hand layup. It weighs one-tenth to one-seventh as much as steel predecessor, and it handles 42,000 cu. ft./min. of highly corrosive, dust-laden air.

achieved, this firm can transport an additional 2 million lb. of its products annually—and at the same operating costs!

2) Maintenance is practically eliminated and so is downtime (a particularly sore point in American industry's current profit squeeze). How effectively this is done is perhaps best illustrated by the 10-ft.-high polyester-glass processing tank described below. In one application involving contact with dilute hydrochloric acid and sulfuric acid, at the end of a 5-year period, the maintenance cost alone for a lead-lined steel predecessor was enough to pay for a new plastics tank.

3) Installation is simple. Using available adhesive or cold set bonding techniques, welding, or other assembly methods, reinforced plastics can be expected to cut installation costs by as much as 30 percent! Where the huge sizes involved can make transportation a problem, it is possible to furnish the structure in smaller molded sections that can be erected in the field—and bonds are as strong as the structural parts themselves.

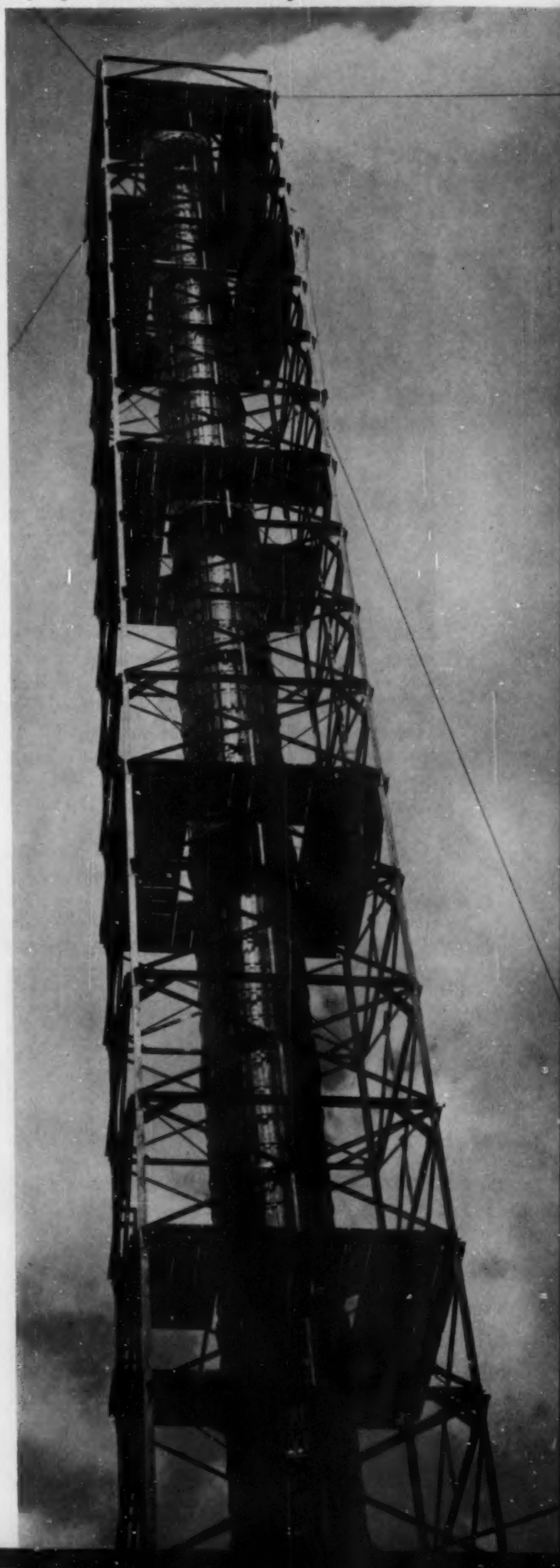
4) Refinements in resins—with particular emphasis on the polyester and epoxies—and in reinforcing materials has given RP a versatility that few other materials can match. You can specify fire-retardant resins for applications where burning might be a problem. You can design trans-

## CASE STUDY #3—*10-year service... no repairs*

**A GLASS-REINFORCED** polyester tank weighs only 3900 lb., yet has strength and rigidity necessary to support an 18,000-lb. load of lead pipe used for carrying live steam. Pipe is coiled inside tank, and is supported by molded-in brackets. Tank top with molded-in connectors is at top right.

## CASE STUDY #4—*Fume stack pays for itself every 16 months*

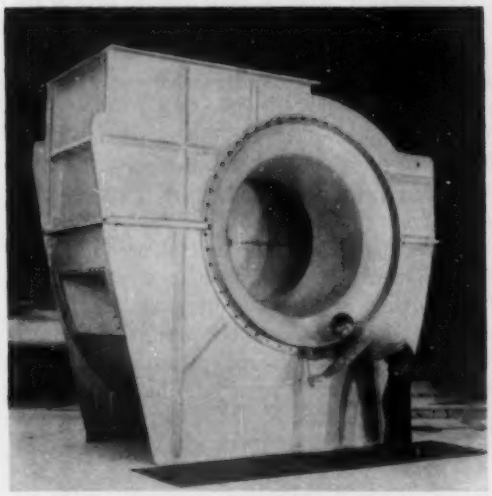
**RISING** 200 ft. in the air (and measuring 5 ft. in diameter), phenolic-asbestos stacks are used to carry off wet sulfur dioxide fumes. Stainless steel stacks previously used lasted only eight months; reinforced plastics stacks are now entering the seventh year of service in this application.



lucency into a reinforced plastics tank so that the level of the liquid stored is always visible—no external glass gages are needed. You can orient your reinforcements to put the greatest strength in the direction called for by the application (the filament winding techniques described below are an important development in this area). You can play up the material's insulation characteristics to eliminate any need for accessory equipment, e.g., to prevent "sweating" in a duct. You can use special fiber overlays where special problems exist (e.g., one manufacturer uses a special veiling of Orlon fibers to increase resistance of a glass-polyester tank to hydrofluoric acid).

What has probably given the giant reinforced plastics structures their biggest boost however, is the number of successful case studies that have already cropped up in a broad spectrum of American industry. In some areas, reinforced plastics structures have stood the acid test of

## CASE STUDY #5—
*Huge fan handles acid fumes*



**POLYESTER-GLASS FAN HOUSING** is made by hand layup in sections to facilitate shipping; is easily assembled in customer's plant. Coated metal tanks previously used required constant—and expensive—maintenance and care (e.g., cutting out corroded areas, welding new plates in place). Reinforced plastics housings are maintenance free.

STEEL CABLE riding freely in slotted vertical seams is used to carry hoop stresses in a line of reinforced plastics tanks, which range in capacities up to 2000 gallons. These tanks cost 5 to 20% less than rubber-lined steel tanks, and cost from 10 to 60% less than stainless steel tanks. This type of tank can be set up easily in the field, even in narrow areas like the one illustrated here.

## CASE STUDY #6—*Savings up to 60%*

time—with service up to 10 years—and with hardly any incidence of failure. In others, the use of plastics structures for industrial purposes is a relatively new concept—but one that is being tested under the most severe and rigorous conditions that industry could dream up. Described below are seven of these case studies. Potential users can find much in them to indicate why and how reinforced plastics have pushed into this fabulous new market.

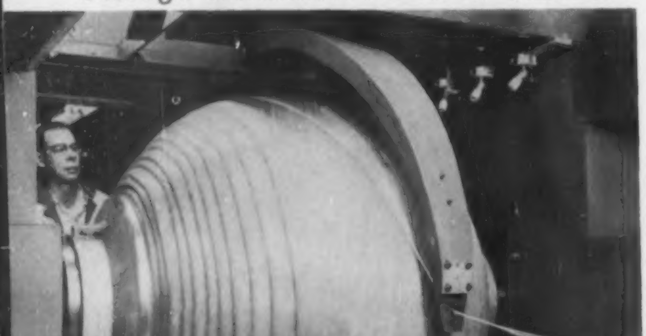
**Case Study #1:** A series of tanks, 12 ft. in diameter and 20 ft. high, for storing, shipping, or processing oils, chemicals, fertilizers, foodstuffs, or potable liquids is now being made by filament winding—and claimed to be the largest commercial structures to be made to date by this technique. As such, they are indicative of how far filament winding has come since it was first developed for pressure bottles and torpedo tube launchers—and how far it still has to go.

The tanks weigh about 1500 pounds. By contrast, a steel tank for the same type of application weighs 10,000 pounds. And although initial materials costs are similar, the reinforced plastics tank represents significant savings in transportation costs to the site. Of course, its corrosion resistance properties are also invaluable in terms of longer service and reduced maintenance costs.

The shell of the tank is fabricated by winding epoxy-saturated filament glass roving over a rotating steel mandrel, using precise helical patterns. In this way, tensile strengths up to 90,000 p.s.i. can be obtained and a constant state of tension is maintained in the finished cylinder. The shell, still on the mandrel, is cured in a large oven for about 4 hr. at 300° F. Following cure, the shell is stripped from the mandrel by a special hydraulic ram system.

The deck and bottom of the tank are fabricated from the same material in flat form. A cylinder of epoxy-glass is wound in the same manner as the shell. Before curing, however, the cylinder is split from the mandrel and placed in a forming and curing pressure-type mold which give it its final shape. The deck is placed over the mandrel used for the shell so that it **(To page 158)**

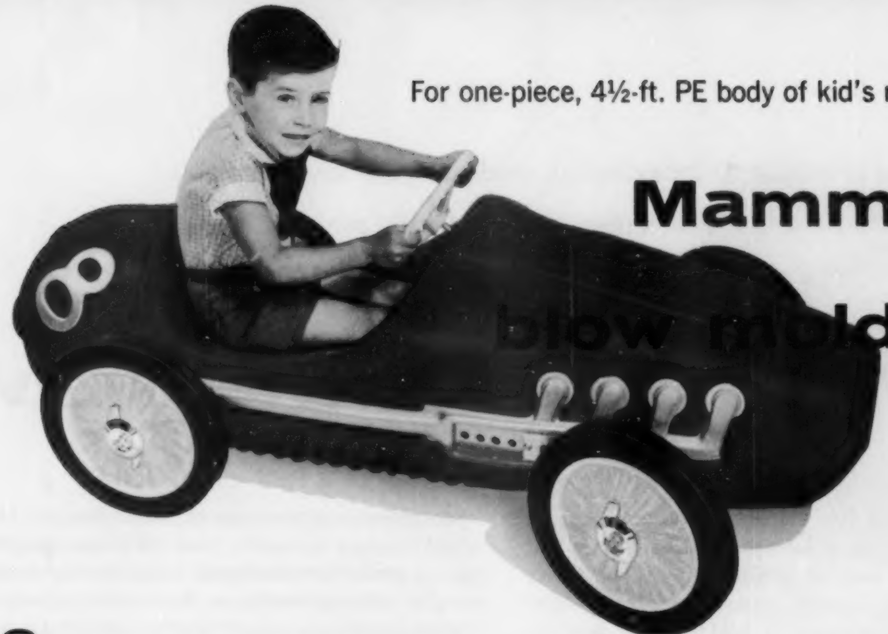
## CASE STUDY #7—*Storage bottles...4½ ft. in diameter*



**FILAMENT WINDING TECHNIQUES** create a spherical pressure vessel for air/gas storage with a volumetric capacity of 10 cu. feet. High strengths made possible by technique result in vessel that can handle up to 5000 p.s.i. working pressures. Inside diameter is 51 inches.

For one-piece, 4½-ft. PE body of kid's racing car:

# Mammoth blow molding



Skeptics who have cast a jaundiced eye on the possibilities of ever using blow-molding techniques for producing parts longer than 2 or 3 ft. are now looking with wonder on what is claimed to be the largest single commercial piece thus far blow molded: the body of a toy pedal racing car of high-density polyethylene which measures 55 in. long and close to 2 ft. high in its deepest sections. For the toy industry, the blow-molded body implies a revolutionary new concept in wheeled goods design; more important, to those other industries that have expressed interest in blow molding, it means that size is not the formidable problem it may once have seemed. And the equipment used for the car body is being readied to produce carboys in capacities up to 70 gal. (in the round) and 90 gal. (in the square).

The polyethylene car body is turned out as a single hollow piece on a custom-built extruder-blow molder. Net weight of the blown body, after the excess parison material has been snapped off either end, is 14 pounds.

Following blow molding, the body is finished in three steps: 1) silver paint for the trim is sprayed on (the body itself is produced in an integral bright red color); 2) the opening for the cockpit (running from the seat around to the steering wheel) is routed out; and 3) all the necessary holes and slots to provide for the attachment of wheels, chain drive, pedals, etc., are die cut out in a single operation on a special jig. The body is then ready for assembly.

Carrying the plastics theme throughout the remainder of the toy car, the wheel rims are molded of high-impact styrene, as is the kick panel guard for the side-mounted chain drive; the steering wheel is high-density polyethylene; hub caps are of metallized molded polypropylene; and all bearings are molded of nylon.

Corrugated ribbing molded into the bottom half of the car body (see photo, below) provides an extra measure of rigidity and strength. And the resiliency of high-density polyethylene, coupled with the fact that blow molding permits the body to be designed as a fully enclosed one-piece unit, offers a riding safety that metal-wheeled goods would be hard pressed to match. Other advantages of the plastic body: it is waterproof and rustproof and there are no sharp edges on which the child can injure himself.

Result: a pedal racing car that effectively combines ruggedness with maneuverability and light weight (the fully assembled unit weighs out at 45 lb.)—and at a sales price of only $35.

*Credits:* Irwin Corp. Nashua, N. H., markets the DeLuxe Racer and molds the body and other plastics parts itself. High-density polyethylene supplied by Celanese Plastics; high-impact styrene by Dow Chemical Co. (for the wheel rims) and by Foster Grant (for the kick panel); and polypropylene by Hercules Powder Co.

**COCKPIT** is cut out of the blow-molded shell, making possible a car with one-piece body construction. Note the stiffening ribs molded into the bottom half of the shell for extra rigidity and support.

If your product calls for extremely vivid hues, the new light-stable, heat-resistant fluorescent pigments may be the answer. Here's how to do it—including formulations and cost factors

# How to use the new

There's good news for plastics processors: Fluorescent pigments—those brilliant hues that can make a finished product up to four times brighter than regular organic colorants—have now been so improved in light stability, heat resistance, and other properties that they are being used today successfully in a variety of molded plastics products, films, and coatings.

The heightened visibility they impart to the items in which they are incorporated is usually sought for one of two basic reasons: 1) improved function of the end product (safety clothing, outdoor display banners, warning signs, marine buoys, for example); and 2) eye-catching merchandising appeal (toys, small household gadgets, and packaging containers, for example). The new fluorescent pigments have chalked up successes in both fields.

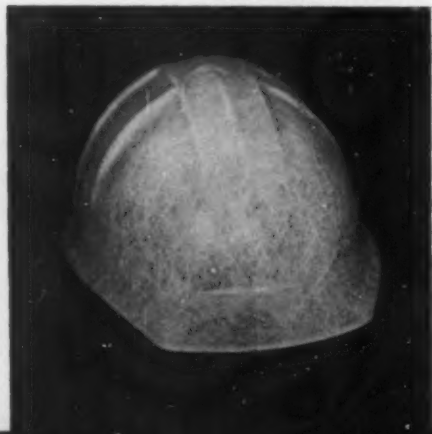
But how can molders and other plastics processors make maximum use of these colorants for added product features? Does their use involve special production problems? How do they compare in light resistance to fluorescent pigments offered several years ago? How about costs—do they significantly increase the price of a plastics product? These are typical of the questions molders and other industry representatives are likely to ask about fluorescent pigments. Here are the answers, based on experiences of end-users and pigment suppliers.

### Where to use them—and where not

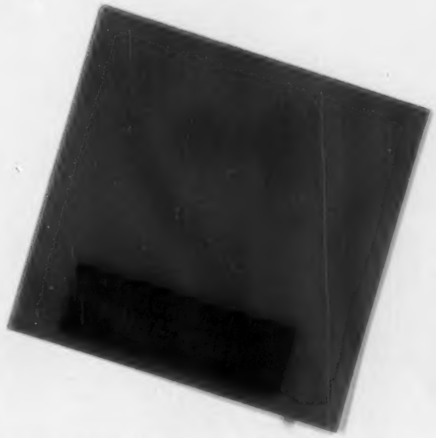
Because of the high intensity of the fluorescent colors, their application in plastics should be based on careful evaluation of the end product and how it will be used. Bright colors are obviously an advantage for such products as playballs, toys, and marine markers. On the other

**SAFETY APPLICATIONS** represent one of the prime uses of fluorescent pigments in plastics. Typical end products include vinyl-coated fabric for hat, jacket, and gloves at left, and RP helmet, below.

Photos: Lawter Chemicals Inc.



# fluorescents



**FLUORESCENT PIGMENTS** in plastics compositions add to visual appeal of end products. Sheet illustrated was compounded and extruded by Gering Plastics, using fluorescent pigments by Lawter Chemicals Inc.

hand, they might be expected to have more limited acceptance for various household items. Consideration should also be given to whether or not the product will be continuously exposed to bright sunlight. Although today's fluorescent pigments have been greatly improved, light resistance can still present a problem.

For example, a Chicago producer of fluorescent injection-molded acrylic numbers and letters reports that under continuous exposure to bright sunlight, the numbers may fade noticeably within eight months or so, whereas in a shaded location they appear to retain their original glowing brilliance for years. As a benchmark, it may be said that the lightfastness of some fluorescent pigments available today compares favorably with that of many conventional organic pigments.

Fluorescent pigments may be used effectively with most thermoplastics, including all types of polyethylene, acrylic, the cellulosics, regular and impact grades of styrene, many types of polyvinyl chloride, and even nylon. Successful results also have been obtained with a number of the polyester resins.

Only minute quantities of the colorant are required for effective results. In polyethylene or polystyrene, as little as ½% pigment, well dispersed, will yield a high-visibility effect significantly brighter than the brightest regular colorant. Other plastics may require a higher degree of pigmentation, depending upon such factors as opacity and thickness.

When used in clear materials, such as general-purpose styrene and acrylics, the transparency of both the pigments and the resins themselves produces a pleasing edge-lighting effect. This property is put to work in one firm's injection-molded acrylic numbers and letters which it places against a white styrene background for use in house number panels and signs.

However, this full-face fluorescent effect also may be obtained in clear plastic materials. This is accomplished by the addition of such fillers as silica gel, calcium carbonate, or talc, which are used in approximately equal amounts with fluorescent pigments.

### How to mix them

Fluorescent pigments, supplied in the form of soft, finely ground powders, present no special mixing or compounding problems. In general, they may be used much like other organic pigments in plastics applications: Resins can be dry-colored or the pigments may be used as dispersions and pastes.

Pigment concentrations may be as low as ½% of a molding compound. However, in extremely thin sections or where the absolute maximum in color intensity and weather resistance is needed, concentrations as high as 35% may be required. Generally, according to one major supplier of these pigments, a concentration of 1 to 2% is a good starting point. Depending upon the concentration required, their use may increase the cost of the finished molding material by from 3¢ to 25¢ per pound.

The extremely fine particle size and other characteristics of these colorants make them comparable to the best organic colors in dry coloring operations; and most suppliers of the "unit" types of dry colorants offer them as part of their standard lines in the form of an easily handled concentrate. In cases calling for extremely critical dispersion, addition of the pigment to the molding

Top photo: Plastic Toy & Novelty Corp. Bottom photo: Lawter Chemicals Inc.

**MERCHANDISING ADVANTAGE** of eye-catching fluorescent hues is recognized by manufacturers of such toys as those above. Children "go for" the bright colors, and fluorescents stand out in self-service displays.

material may be handled by compounding. Many suppliers also offer standard or custom resins precolored with fluorescent pigments.

Like other organics, fluorescent pigments are somewhat sensitive to prolonged high processing temperatures. Thus, for maximum effectiveness when used with plastics, the heat history of the material should be kept as low as possible consistent with efficient molding cycles. Although molding and extruding temperatures above 400° F. are satisfactory when using the fluorescents, lower temperatures are desirable, especially with the less temperature-resistant reds and oranges.

### *How to color vinyls*

Excellent color and brightness can be obtained in vinyl plastisols, organosols, calendered film, and molded articles through the use of properly selected fluorescent pigments. Fluorescent-colored vinyls also have better light stability than some other types of plastic resins, because some pigments offered for vinyls by the basic fluorescent color suppliers contain an ultraviolet light absorber (*e.g.,* tin mercaptan) which is said to give the finished product improved light resistance. Still, pigment suppliers recommend outdoor exposure or Weatherometer tests to determine whether the light stability of a given formulation is acceptable.

With vinyls, according to one source of the fluorescent pigments, the concentration of pigment can range from 1% to 35%, depending upon the thickness of the article or film and the degree of light stability desired. This company suggests 20% as the highest practical working content for vinyl plastisols and 30 to 35% for organosols. Dispersion in plastisols and organosols in most cases can be accomplished by simple stirring; predispersion in plasticizers is not necessary.

A typical plastisol formulation, such as that given below, can withstand processing temperatures of 350 to 400° F. for periods of from 5 to 20 min. without loss of brightness:

| | |
|---|---|
| Geon 121 (B. F. Goodrich Chem.) | 52.0 parts |
| Dioctyl phthalate | 13.5 parts |
| Dioctyl adipate | 13.5 parts |
| Epon 828 (Shell Chem.) | 3.0 parts |
| Fluorescent pigment | 18.0 parts |
| | 100.0 |

Another suggested vinyl plastisol formulation includes 94.5 parts clear rigid plastisol, 2.5 parts of talc, and 3 parts of the finely powdered fluorescent pigment. Such a formulation would be milled and deaerated before using, then fused at 350° F. for 5 to 10 minutes.

According to one company specializing in vinyl compounding, use of fluorescent pigments in plastisols may require added attention to these factors, all of which are controllable: viscosity stability; excessive temperatures (which may affect the shade of color); and ultraviolet stability, crocking, and bleeding.

One supplier of fluorescent pigments outlines the following procedure for handling them in conjunction with vinyl chloride:

"Plastisols or organosols are prepared by mixing the ingredients in a heavy-duty mixer having high shear rather than high speed. The vinyl resin is added in portions to a mixture of plasticizers and stabilizers, with mixing continued until a uniform paste is obtained. Thereafter, the pigment is added in portions and folded quickly into the plastisol with slow stirring until a paste, free of agglomerates, is obtained. Deaeration, if necessary, should be carried out at this point."

This company states that with the use of high pigment loads and/or non-migrating plasticizers, the addition **(To page 166)**

Photos, Rubber & Asbestos Corp.

**POLYETHYLENE** foam slabs of 1½-in. thickness form safety cushion atop the hard concrete rim of trampoline pit. In this application, an outgrowth of the nation's newest sports fad — group jumping — PE foam's resiliency, weather resistance, and easy bondability won it the nod as a replacement for film-enveloped foam rubber.

# PE FOAM TAKES THE JUMPS

Recognizing the fact that foamed polyethylene (PE)—unlike its solid counterpart—can easily be adhesive-bonded to various materials, a manufacturer of trampolines has found a unique way in which to put the excellent shock absorbing characteristics of the foam to work. Prospective users who have been considering possibilities for the new low-density cellular polyethylenes—beyond their current applications in gasketing, insulation, and buoyancy—would do well to study this one.

As set up for group jumping—the latest American sports fad—the trampolines are erected over pits dug into the ground and are supported by springs attached to metal fastenings sunk into the concrete set around the rim of the pit. The problem lay in finding a cushioning material that could be laid over this hard rim. Originally, the manufacturer used a 4-in. slab of foam rubber sewed into a plastic film covering for protection from exposure to sun or rain. The foam rubber, in its plastic envelope, then had to be strapped on or bolted down over the concrete.

When the decision was made to switch over to a plastics foam, the manufacturer and fabricator ran through the list of available materials and eventually settled on a 1½-in.-thick slab of PE foam in densities of 1.7 to 2.1 lb./cu. foot. Reasons for the selection: 1) the PE foam in thicknesses of 1½ to 2 in. provided the same degree of shock absorbency as other foams in thicknesses of 3 to 4 in.; 2) the outstanding moisture resistance of the material eliminated any need for a covering; and 3) thanks to the cellular structure of the foam, adhesives could be used to effect a firm bond between foam and concrete.

In production, the PE foam slabs are cut by band saw into sections 9 ft. long and 12 in. wide, with mitered corners. To install, adhesive is simply brushed on the corners and the two sections of foam are pressed together by hand. The underside of slab and the concrete surface are also brushed with adhesive and the slab is pressed into place. There is an added advantage that derives from the use of PE foam. Previously, the plastic envelope that covered the foam rubber would wear away, necessitating the replacement of the entire slab. With the PE foam, as segments wear, they are simply cut out and a new piece bonded in place.

**Credits:** Ethafoam polyethylene foam—by Dow Chemical Co.; Bondmaster G590 adhesive—by Rubber and Asbestos Corp., Bloomfield, N. J.; foam slabs fabricated and supplied by Markel Rubber Products Co. Inc., Bronx, N. Y., for the MacLevy Leap-N-Bounce Corp., New York, N. Y.—**End**

**ADHESIVE BONDING** of PE foam cushion is accomplished with double-coatings: on concrete surface and underside of slabs, pre-cut to size, and on both edges of mitered corners.

TRANSIT is used to check alignment of aluminum templets used in making plaster patterns for RP molds. Horizontal and vertical alignment of each templet is made by fasteners at floor level; rods serve as anchorage for hardware cloth.

# REVOLUTION IN TRANSPORTATION:

# The reinforced plastics


COVER ART, HOLIDAY HOUSE INC.

Trailer—Design Pat. Pending

TAKING ITS CUE from the success of reinforced plastics honeycomb structures in military aviation, Holiday House Inc., Medford, Ore., has now brought these design concepts down to earth and applied them to a line of deluxe traveling trailers—and at a price competitive with conventional units!

The idea is an intriguing one: how to translate the principles involved in creating high-strength, close-tolerance plastics military structures into a commercial production job—within the broader limits the latter allows and without sacrificing any of the quality of the former. Holiday House's success with the idea has implications that can have an important bearing on other potential markets for reinforced plastics in transportation.

Of course, the very fact that a producer of high-quality trailers goes to a reinforced plastics body (after starting out in business with conventional wood-aluminum construction) represents a milestone, and the added fact that the resultant plastics product is competing successfully on both a price and performance basis with these well-established and long-accepted materials is noteworthy. Of interest, too, to anyone contemplating a move into reinforced plastics is the speed with which a newcomer to this field was able to get into production: It took just six months, using part-time help from local aircraft and missile plants, to obtain a complete set of production molds and assemble the prototype. All these facets are important. But it is in the why and how of this development that its true significance is found.

One of the keys to Holiday House's success was the design effort put into creating patterns for the molding job.

**This article is based on information supplied by Robert Brian Brophy, who served as plastics consultant to Holiday House Inc., and to Industrial Design Affiliates.**

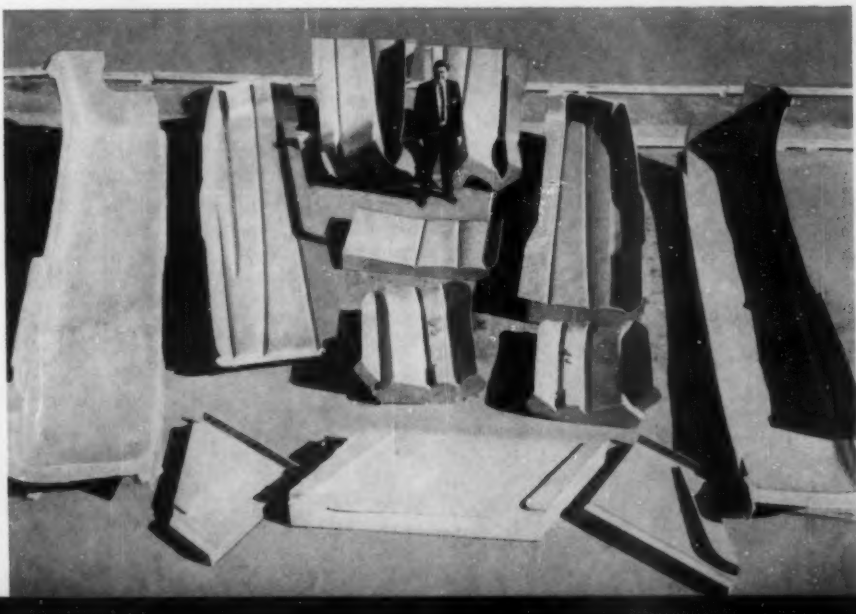
### *Creating the plaster patterns*

If you can imagine a trailer sliced vertically down the middle, fore to aft, and each half then tipped over to rest upon the cut surface, you will have a picture of the two basic plaster patterns which were used. The foundation of each pattern was constructed of two parallel steel channels, leveled and lagged to the shop floor, and joined by steel angles welded to the channels at station intervals of 1 foot. Aluminum, rather than steel, sheets were used for templet stock; although aluminum is five times the cost of steel, it is easier to cut and file it to a precise line.

The finished aluminum templets were set on edge at stations 1 ft. apart and held in place with all-thread steel rod, passed through each templet 1 or 2 in. below the working surface and at in-

**PLASTER PATTERNS** nearing completion begin to look like the trailer sliced down the middle. More than three tons of plaster went into making up the patterns on which were formed the 700 sq. ft. of RP molds used in making the prototype trailer.

# travel trailer



**TWELVE MOLDS** were made for the body of the trailer. Shown in photo: two for the roof (extreme right and left); one for each side panel below the windows (immediately to right and left of figure); two for front panels (behind figure); one for the door (at feet); two for rear panels (with circular insets for tail lamp holes); and three (foreground) for panels that form upper sidewall.

tervals of 6 to 10 inches. The rods afford an excellent means of anchorage for the hardware cloth which is later laid down as a reinforcing bed for the plaster.

A rough coat of plaster was then screeded over the wire cloth and coated with shellac. The shellac serves a double purpose: 1) it prolongs the workability of the finish coat by slowing the loss of its water content and, 2) the shellac acts as a parting medium, facilitating removal of faulty areas of finished plaster without any need for chipping into the rough plaster base. The finished coat of plaster was then splined over the rough coat with a flexible straight-edge drawn across the open spaces, using the exposed edges of the templets as guide rails. More than three tons of plaster went into the patterns.

**LOWER HALF** of trailer begins to take shape as RP parts are joined in initial stages of assembly on trailer chassis. Note cracks between edges of panels; these seams will be filled in and covered by final painting. Longest seam, on roof, measures 20 feet.

### *Making the molds*

After the patterns were completed, the moldmaking began. For each mold, the plaster pattern was first polished and then treated with several applications of mold release. Over this was applied the tooling gel coat—an epoxy resin highly filled with aluminum to a putty-like consistency and thoroughly mixed with hardener.

The coat was permitted to gel before any cloth was applied in order to prevent subsequent migration of the cloth to the surface of the tool, where its fabric pattern would be objectionable. Three plies of glass cloth were then laid on the gelled surface and impregnated with a fifty-fifty blend of two epoxy resins. The resins were blended to achieve a viscosity rating midway between their respective levels. In the smaller molds (e.g. for front panels), six plies of woven glass roving were needed to complete the lay-up; in larger molds (e.g. for the roof), eight plies of woven roving were added.

The roof molds are the largest of the group; each is 24 ft. long, almost 5 ft. wide, and, at one end, 55 in. high. Each required the services of six laminators and one resin mixer for about 8 hr. to lay up the required 166 sq. yd. of glass roving, impregnated with 25 gal. of epoxy resin (waste and trim included). A finished roof mold, complete with its plywood base, weighs approximately 600 pounds.

The left and right lower side panel molds are nearly as massive. **(To page 172)**

**ASSEMBLED TRAILER** awaits only glass for windows and interior fittings. Clamps hold inset wooden fittings to which non-plastics elements (window frames, etc.) will be bolted. Light weight of trailer permits it to carry extra features such as air conditioning and independent electrical system.

# A nylon housing for your product?

Five manufacturers of portable electric appliances have housed them in this plastic—here's why

Photos, Du Pont

**HOUSING FOR** electric drill, molded in two parts of nylon 6/10 material, replaces aluminum case. Switch was made to provide necessary properties to meet strict European insulation standards and thus provide export market for the tool. Choice of nylon may also make it unnecessary to redesign the equipment for a three-prong plug to meet imminent Underwriters' Laboratories standards here.

Last year, just in time for the Christmas gift-buying season, a leading maker of electric shavers introduced a new model housed in molded nylon. To observers in the plastics industry, this decision carried major significance, especially in view of the fact that at least four other makers of portable electric appliances have also turned to nylon.

It gave impetus to a trend that is moving nylon into areas beyond the relatively small-volume, small-size mechanical applications. No longer is the material limited to cams, bushings, and bearings. It has breached the market of big-volume, large-size components.

The big question is "why?" It's a simple question, yet the "because" involves many different factors. And each one points to the probable increased use of nylon for housing applications.

A prime factor in its use is the good balance of desirable properties it offers: toughness, high impact strength, resistance to abrasion, high heat distortion point, and continuous service at high temperatures.

In addition, nylon offers the processor general ease of molding and rapid cycling, once certain adjustments are made in molding procedures to account for nylon's sharp melting point and moisture-absorbing characteristics.

As a result, nylon can frequently represent at

Photo, Foster Grant


**SCHICK SHAVER** now features a shatterproof nylon case. Nylon replaced melamine in this application because former's greater impact strength, dimensional stability, and light weight could be had at little increase in cost when speed of injection molding and elimination of deflashing were taken into account.

least one major advantage over other materials—plastic or non-plastic—with which it comes into competition for the appliance housing market.

Of course, since these factors always existed, the second big question is: why the sudden plethora of nylon applications? Two recent developments are generally felt to have played an important role. One is price, which was dropped to 98¢/lb. last year; the other is the increasingly stringent standards, promulgated by Underwriters' Laboratories and A.S.T.M., for appliance housings, as they involve the use of materials with self-extinguishing and insulating properties.

Here is how these factors, in various combinations in each case, won for nylon the selection as the basic material for the housing of six electrical appliances.

### *Schick shavers: from melamine to nylon*

Perhaps the most significant application of nylon to small electrical appliances was the use of the material for the Schick 10-66 three-speed electric shaver. While nylon has always had heavy use in internal parts for shavers, this model (and two others in the firm's line) is one of the first to use it for major housing components. In fact, one model in the line (Model 80) uses nylon for the basic case, as a side panel for the control buttons (also nylon) and the two whiskits, which give access to the shaving head for cleaning.

In this application, injection-molded nylon replaces compression-molded melamine. The reasons, according to the manufacturer: in comparison with melamine, nylon offers greater impact strength and good dimensional stability; and these characteristics could be had at little or no increase in cost. The switch to the faster injection-molding process and the elimination of deflashing operations which were necessary with melamine, brought per-unit costs fairly close in line.

Nylon also provided a merchandising advantage: light weight. The finished case for the Schick shaver weighs approximately 2 oz.—about 25% less than the melamine housing.

### *For top electrical insulation*

Nylon's superior insulation properties were the basis for its selection in a portable electric power drill (see photos, p. 95)—as a replacement for die-cast aluminum. The maker, Millers Falls Co., Greenfield, Mass., had long been interested in the potential export market for such hand tools and had sought to double-insulate its products to conform with the rigid specifications of the European Commission for Electrical Equipment (CEE). The CEE requires that conventional motor insulation in such tools be supplemented by secondary insulation of external metallic parts, *e.g.*, chuck, spindle, and housing. The substitution of nylon for aluminum in the housing—and the substitution of a polycarbonate chuck for the conventional metal one—served to bring the company's product within European specifications, opening a broad new market.

Now the switch to nylon housings may bring the company an added dividend at home. Some time ago, Millers Falls Co. learned that a proposed Underwriters' Laboratories standard, scheduled to go into effect in July of this year, would require a three-prong plug (to insure proper grounding of current) on all power tools intended for home use. At present, such shock protection is required only on industrial tools.

Because three-prong devices—and the outlet plugs needed for them—will not be in wide-spread use for several years, the company approached U. L. on the feasibility of re-writing its standard in terms of the double-insulation provisions of

the CEE; it is understood that U. L. is now considering this as a perfectly acceptable alternative safety provision.

The double-insulation feature of the nylon housing has been turned to good merchandising advantage by Millers Falls Co. It has dubbed its product "Safe-T-Drill" and stresses its shock-proof qualities in its advertising.

Added advantages of the new nylon housing listed by the drill manufacturer are: flame resistance, comfortable "feel" in cold weather, and a ½-lb. reduction in weight.

### *Flame-resistant soldering gun*

Another tool for the do-it-yourself market now housed in nylon is a light-duty soldering gun made by Portable Electric Tools Co., Geneva, Ill. With the introduction of this new tool, the company has added a consumer item to its established line of large, metal-housed soldering guns for industrial use. The nylon component is said by the maker to conform to U. L. standards on electrical insulation and flame resistance, and provide sufficient impact strength to protect the transformer-type heating element of the tool from impact shock. In addition to the two-piece housing, the gun features a molded nylon trigger.

### *Clipper and can opener*

Not any one outstanding property, but again a "balance" of desirable characteristics, was responsible for the choice of nylon 6 for housing two products of the Supreme Products Corp., Chicago. Introduced a little over a year ago by the firm were a nylon-housed electric can opener and an electric hair clipper for home use. Supreme Products lists these advantages as resulting from nylon's "balance:" high impact strength, good surface gloss, and hardness combined with ease of molding. The material's heat insulation and self-extinguishing characteristics also played an important role in its selection.

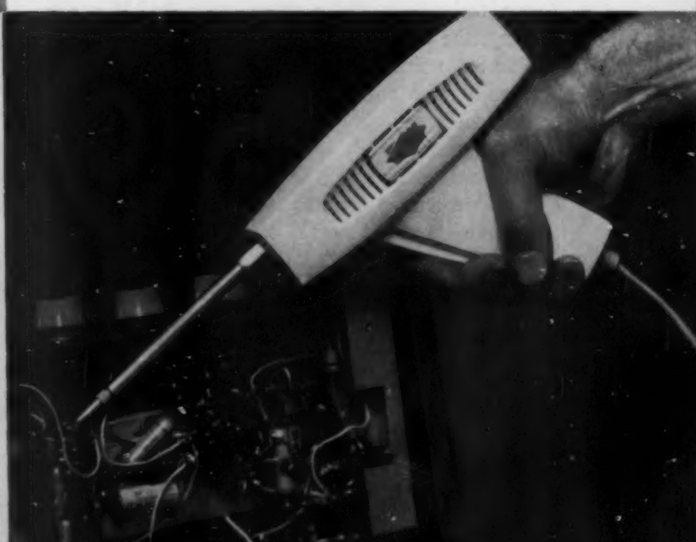
The two individual nylon shells which make up the can opener housing weigh only 1 oz. each, and comprise about 5 in. of the total 8½-in. length of the appliance.

### *For industrial tools, too*

While it is the consumer market that has so far led the move to nylon housings, industrial tools are also potential customers. Typical of the applications developing in this field is a glass-filled nylon housing for a spray gun marketed by B&G Co., Plumsteadville, Pa. The gun, used for insect extermination, differs from more conventional metal-housed products in at least one important feature. In the B&G product, the hose from the fluid supply leads into the butt of the nylon gun, whereas in metal (To page 171)

Photos, Allied Chemical Corp.

**GLASS-NYLON** design for spray gun permitted redesign of tool to incorporate feed hose in out-of-the-way position in butt of gun. Nylon material also provides good resistance to impact and corrosive spray fluids.



**FLAME RESISTANCE** and high impact strength won nylon the nod for housing of new soldering gun for do-it-yourselfers. Nylon's electrical insulation standards won Underwriters' Laboratories approval, while high gloss added merchandising appeal.

Photos, Leathertone Inc.

# And now with

**DECORATING TECHNIQUE** is simple three-step process. As applied to sunglass frames it requires: a thin sheet of decorative acetate laminate (top), out of which is cut the required shape (center). The die-cut shape is then placed face-down in a mold and the acetate is molded on top of it. Finished frame (bottom) incorporates the decorative laminate as a molded-in surface.

Until recently, surface decorating of molded products *during the molding cycle* was confined to thermosets. Now a technique has been developed that makes it possible to do the same with thermoplastics; and thus the decorating potential of plastics has been given new breadth.

Except for the fact that the decorating operation has been made part of the molding cycle, the two techniques differ quite radically. For one thing, the decorative laminates are introduced at different points in the molding cycle. With the thermosets, a resin-impregnated paper foil, properly decorated, is placed into the loaded mold during the "breathing" phase of the cycle. For thermoplastics, a 20- to 30-mil laminated sheet is the decorating medium and is placed face-down in the mold at the start of the injection cycle. The position of the decoration in the finished molded part also differs. With the thermosets, the decorative foils are molded in *under* the clear surface of the part. In the thermoplastic version, the laminate sheet becomes the final finished surface.

But whatever the differences, the new concept gives the plastics processor an additional finishing tool wherewith to upgrade his product.

Originally, the new technique was developed as a low-cost, high-quality method for decorating sunglass frames. But it has already been adapted to the production of cosmetic containers, combs, and hair ornaments. And in the offing: housewares, radios, appliances, wastebaskets, mirror backs, buttons, buckles, heels, fountain pen barrels, and a host of other applications.

### *How it is done*

The technique is relatively simple. The only know-how to be acquired is mold design—and even here existing molds are said to be easily modifiable for work with the process.

To use the process, the lamination (with decorative elements locked between clear sheets) is first die cut to the shape of the bottom of the mold cavity. Cutting should preferably be done with steel-rule dies that are made directly from the mold templets.

The die-cut pieces are then laid face-down in

# the thermoplastics, too...

# DECORATE RIGHT IN THE MOLD!

the cavity. Molds must be gated from the top to assure proper results.

During the injection cycle, the melt of the material being molded flows on top of the laminate and a small amount creeps along and wraps around the edge, locking the laminate as a permanent decorative surface to the molded piece. It is important to cut the edges sharp so that the melt does not flow around the laminate.

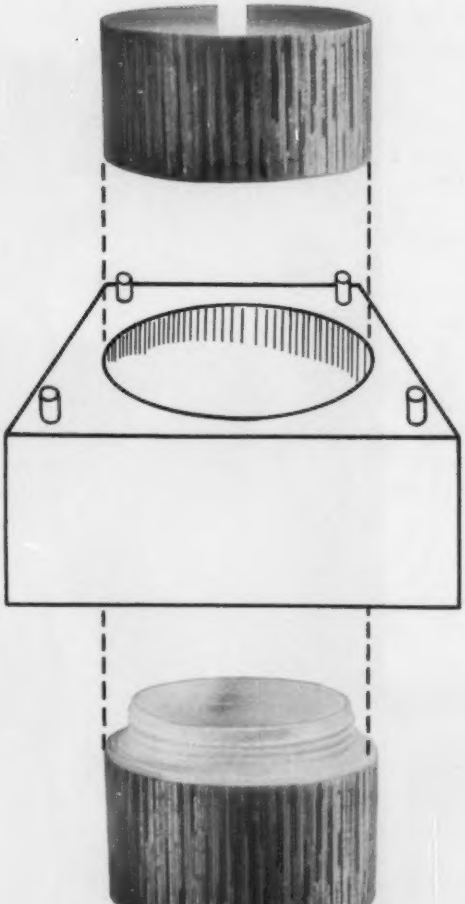
One laminate supplier recommends that the reverse side of the die-cut laminate be coated with a special adhesive (full-size sheets already reverse-coated with adhesives that are reactivated during the molding cycle are also available) and strongly urges that a vertical injection molding machine be used. However, half of the molders currently working with the technique report they *do not* use any adhesive; and several molders have turned out successful jobs with horizontal molding machines. Some of the processors are using thin pins in the male part of the mold as extra insurance that the laminate will stay in place during molding.

### *Some refinements*

To speed up production, a loading board can be used to position the laminate inserts in the mold. At several plants, special mold set-ups for vertical machines have been developed. These consist of a single male and two female molds equipped with swinging bracket assemblies. When one of the female molds is in the machine, the other is being loaded outside the machine. At the end of the cycle, the loaded mold is swung into the machine while the other one comes out for stripping and reloading with inserts.

### *Versatility in application*

Acetate sunglass frames were the first application of the "insert decorating" technique. It originally showed up about **(To page 176)**



**FOR CIRCULAR SHAPES,** laminate (in this case, styrene) is bent into cylindrical form (top) and inserted into mold (center) so that it snaps out and clings to walls of the cavity. Molding with styrene is done on top of the laminate. Result: a decorative cosmetic jar (bottom) that requires no finishing. In production, job is run on horizontal injection machine.

Molded polyester "buttons," incorporating reflective glass beads and bonded to road with epoxy resin, may bring solution to long-standing highway safety and maintenance problems . . . without pain to taxpayers

# Traffic markers that shine– and last


After several false starts, plastics may finally succeed in getting a good piece of the lane marker market. The reason for this optimism: a glass-filled polyester "button" and an adhesive system designed to bond them firmly to the road.

The market? Potentially 2½ million miles of surfaced road in the U. S. requiring 10,560 buttons per mile per lane divider. Overseas applications would increase this total appreciably.

The immediate selling point of the new marker is improved road safety: For the first time, motorists will now be able to see lane divisions clearly on rainy nights and in fog. This is a tremendous step forward in road safety.

In addition, the new buttons . . .

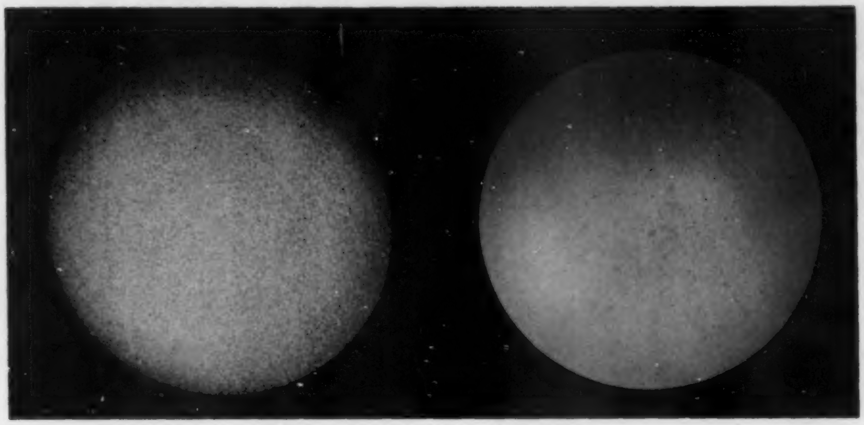
- have a service life estimated at betwen 10 to 20 years and, in general, may outlast the roads on which they are used (painted lines require renewal from once every six months—in heavily travelled areas—to three years);
- present no increase in cost over standard painted lines, and may bring actual savings;
- are so designed that motorists crossing a lane marking can actually feel it, and thus be warned of any drift in the car.

There are certain conditions, however, under which these markers may not be suitable; examples: where roads are subjected to the extraordinary impact of tire chains for long seasons, and where snow plows are likely to be used.

### What are the costs

The markers are designed roughly in the shape of a spherical segment, 4 in. in diameter at the base and 0.62 in. high at the apex. The lower

**NIGHTTIME VIEW** of traffic markers installed on California freeway and illuminated by oncoming automobile.



**REFLECTORIZED** (left) and unreflectorized traffic markers, showing how same light source on the "buttons" results in different reflectivity.

section forms a flat disk-like base supporting the spherical segment. This base is 0.12 in. high. Tolerance for overall height and base thickness is 0.03 inch. The underside of the marker has a flat rough-textured surface having a concavity of not more than 0.05 in. and a convexity of not more than 0.01 inch.

This configuration and composition is in accordance with California Department of Public Works, Division of Highways specification, issued May 1960.

In actual applications, the buttons are bonded to the road, four to each 24 ft. of delineated lane. The buttons are placed 3 ft. apart, so that the final configuration is 9 ft. of buttons, 15 ft. of space, etc., or 880 buttons per mile. On that basis, cost per mile, installed as a single line between adjacent lanes, is about $550. Conventional paints cost about $100 per mile when first placed on a new highway, and $40 per mile for repainting. Thus, on heavily travelled roads, the cost over a 10-year period is about the same for the buttons as for the paint. Any additional service life provided by the polyester buttons (and tests on California highways indicate that they can generally be expected to last more than 10 years) will represent pure savings.

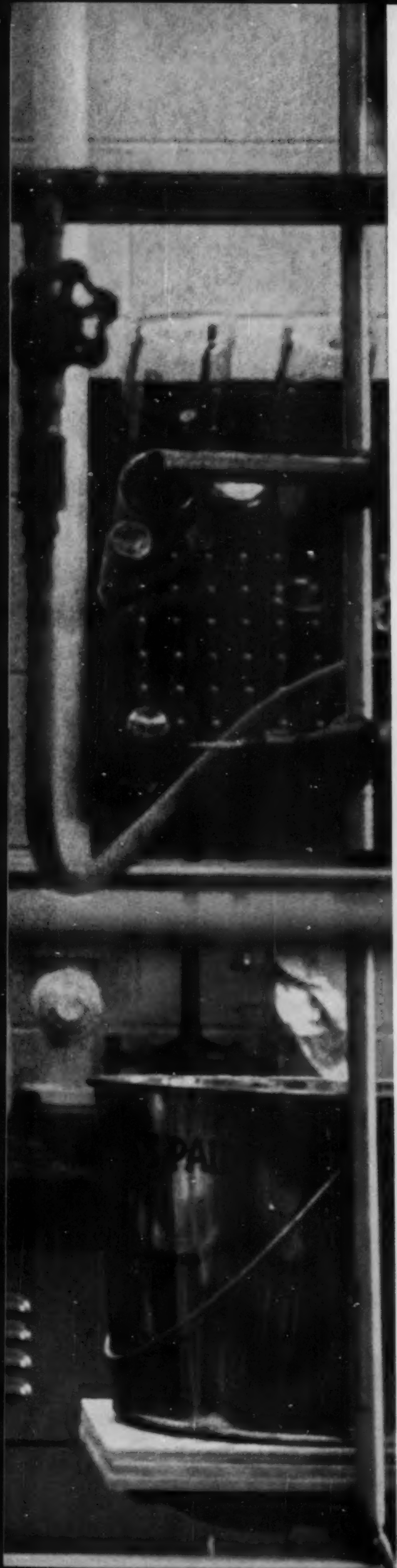
### *Glass beads give strong reflectivity*

What makes the polyester buttons so effective as night-time markers is the strong reflectivity they provide to motorists. This is the result of several hundred thousand tiny glass beads—none larger than 0.02 in. in diameter—that are embedded in the polyester resin. Unlike white surfaces, which reflect incident light in a semicircular pattern, the glass-reflectorized traffic markers reflect directly back to the source. While this is a great advantage on rainy nights, it does however, pose a handicap under conditions of strong overhead lighting. For those conditions, a satin-finish, non-reflectorized marker that does not incorporate glass beads is used.

### *How buttons are made*

In the first step, liquid polyester resin is mixed with glass beads, titanium dioxide white pigment, accelerators, and promotors. The respective minimum proportions are 20% polyester, 70% glass spheres, and 5% pigment. These minima are required by the California Highway Dept. specification covering these markers. The mixture is then cast into molds that give the markers their final shape. Postcure in an electric oven develops the necessary strength. As a final production step, the top surface film of polyester resin is stripped from the button, exposing more than 30,000 glass spheres. Weight of finished **(To page 178)**

**CAST POLYESTER MARKERS** go through electric oven for final cure. In the reflectorized type, top layer is subsequently stripped.



Joe Foster considers the scope of
Foster Grant's research and development.

# "Stereospecific polymerization catalysts may trigger a materials revolution," says Joe Foster

That's what my research and development group tells me. And, we've been giving this area top priority, along with polyamide polymers and co-polymers and graft polymerization.

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Body and legs of Madame Alexander 36″ nurse doll (A) and 15″ Cathy doll (B) blow-molded of Bakelite Brand high density polyethylene for Alexander Dolls, Inc., New York, N.Y. Ring (C) and bead (D) sets and wheels for toy racer (E) blow-molded of high density polyethylene by Fisher-Price Toys, Inc., East Aurora, N. Y.

UNION CARBIDE

George R. Smoluk, ENGINEERING EDITOR

PLASTICS ENGINEERING*

PROCESSING • FABRICATION • PRODUCT DESIGN • TOOL AND EQUIPMENT DESIGN

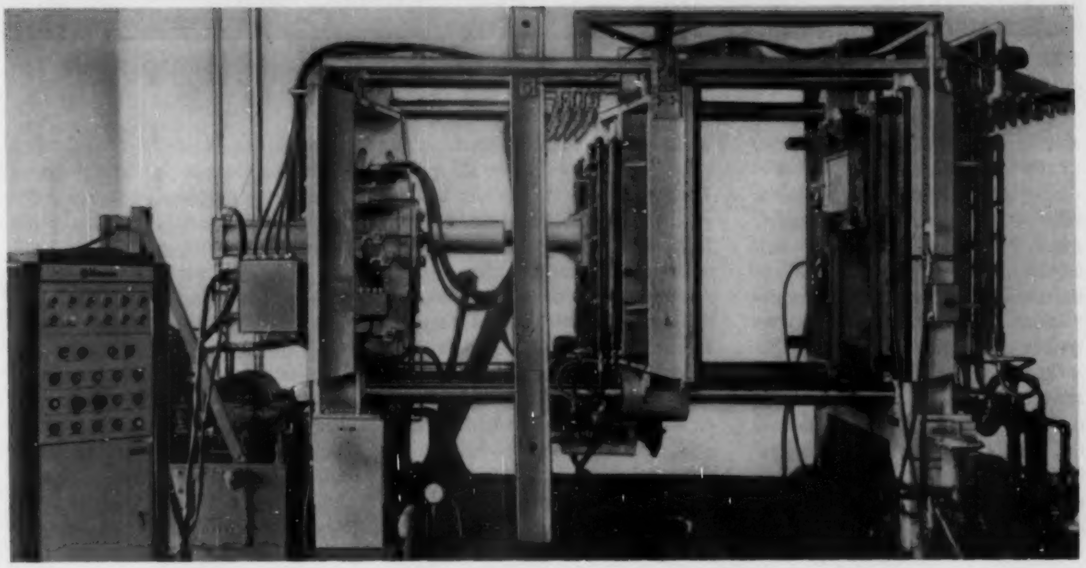

FIG. 1: Automatic molding press for expandable polystyrene foam. Hydraulically actuated movable platen is shown to right of center. Adjustable grid system at right replaces platens for mold mounting. All segments of the molding cycle are controlled by timers on control panel at extreme left.

# Foam molding goes automatic

Newly developed equipment makes it possible to go from raw polystyrene beads to finished moldings in a matter of minutes

By Frank H. Lambert†

In the surprisingly short time of a year and a half, the molding process for expandable polystyrene beads has been transformed from an awkward manual operation into a fully automated process. This significant breakthrough has been made possible through the development of equipment for 1) automatic and continuous expansion of raw beads, 2) automatic filling of foam molds, and 3) completely automatic molding of the pre-expanded beads. The three units involved are available separately, but are generally sold as parts of an integrated foam molding line. Figure 1, above, shows the molding press. The flow sheet of an integrated line is illustrated in Fig. 2, pp. 108-109.

This article discusses the operations involved in automatic foam molding and how their analysis led to the developments of the equipment above.

### Pre-expansion

In this stage of the foam molding process, the raw, expandable polystyrene beads or pellets are heated to soften the material and allow the propellant in the beads to expand them to a bulk density equivalent to the final density desired in the finished product. Note that it is the bulk density of a quantity of pre-expanded beads and not the density of a single bead which will be equivalent to the density of the final foam. In fact the density of the individual beads themselves will be slightly greater than the final foam density desired, since the interstices of air between the pre-expanded beads will form a part of the final foam product and must be considered as part of the charge to the mold.

Because the pre-expansion step will control the final density of the ultimate molded product, the bulk

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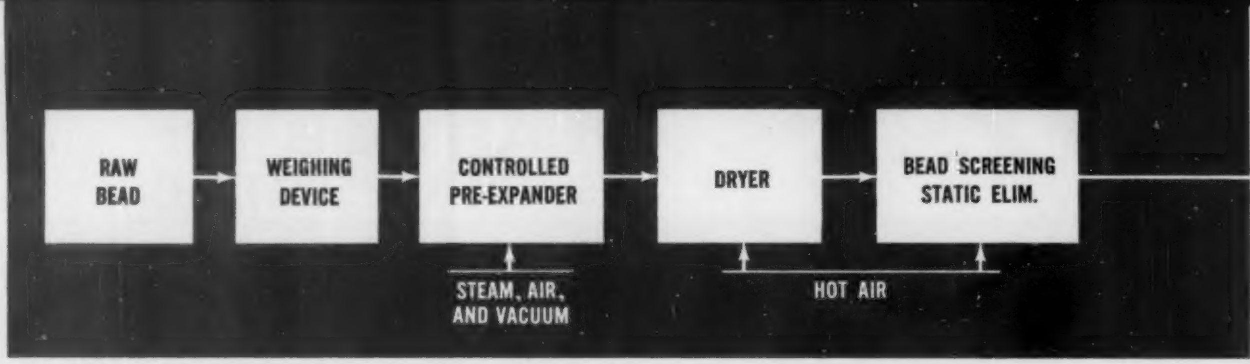



**FIG. 2:** Schematic flow sheet of an automatic polystyrene molding line.

density of the expanded beads fed to the mold must be controlled to within about 2 to 3 percent. If the bulk density varies considerably more, it will be impossible to control the uniformity and quality of the molded part and significant deviations from the estimated material cost will probably result. This is due to the fact that the beads are charged to the mold on a volumetric basis (the fixed volume of the mold cavity) and as density of the charge varies, so does the weight and cost of material used to make a given part.

The heat used for the expansion of the beads is usually steam in the pressure range of 15 to 25 p.s.i.g. For uniform and reproducible expansion of the beads to a given bulk density, it is essential that each bead be subjected to the same amount of heat for the same amount of time. With this in mind the pressure of the steam and its quality (moisture content) must be absolutely constant during the time of exposure. The amount of heat supplied as well as its rate of application are also critical in the control of the bulk density of the expanded beads. If the steam is applied too rapidly and the expansion of the bead takes place in too short a time, the thermal shock of the bead emerging from the pressurized expansion chamber, into the lower pressure of the atmosphere will cause a collapse of the bead due to the contraction of the expanding gases within the bead.

Another critical factor in the production of uniformly expanded beads is the actual composition of the expandable polystyrene material itself. The volatile content, consisting of the propellant, absorbed moisture, or other materials, must be uniform or individual beads will not expand by the same amount. This may result in significant variations in the overall bulk density of the expanded beads. Material suppliers usually exercise careful control over this variable to maintain uniformity. However it is also advisable for the user of the beads to run checks on the volatile content of the raw beads in his own plant; storage under various conditions of time, temperature, and humidity can cause changes in propellant concentration or other volatile content.

To check volatile content of the raw beads, a representative sample of the pellets is taken and a known weight of same is measured into a small aluminum container. The container is placed in a constant-temperature oven at 150° C. for 30 minutes. The container is removed, cooled, and the contents reweighed. The percentage of volatile content is found by dividing the loss in weight by the original weight of the beads. If the volatile content of the beads being used varies considerably from batch to batch, the manufacturer of the beads should be advised, and further checks should be made to ensure that the beads are not stored in an area with excessive temperatures or in open

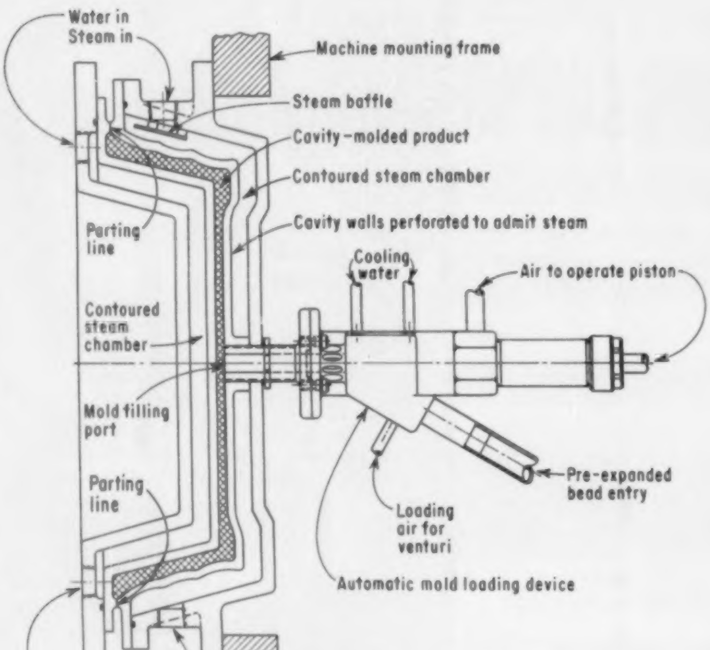



**FIG. 3:** Cross-section of a typical mold used for automatic foam molding. Also shown, to the right of the mold, is the device for automatically loading the pre-expanded bead into the cavity.


containers where they may be subject to the loss of propellant.

Another consideration in the pre-expansion of beads is the desired size of the expanded bead. In some molded articles, e.g., involving a thin wall section, a very small expanded bead may be necessary for proper mold fill. In these cases, the molder will have to determine the size of the expandable pellet to be used consistent with the density of foam desired, or the amount of pre-expansion that should take place, and whether the expanded beads should be sifted to insure the proper size.

In fully automated molding processes the pre-expanded beads should be completely dry to insure a free flow through automatic mold loading devices. Since steam is used to pre-expand the beads, they should be dried to remove the condensed steam after pre-expansion. If forced-air drying is used agitation of the pre-expanded beads by the air may build up static electrical charges which cause the beads to agglomerate or stick to feed chutes and conveyor ducts. It is, therefore, advisable to use some form of destaticizization to neutralize the electrostatic charge on the expanded beads prior to molding.

As implied before, the absolute value of the bulk density of the expanded beads will be determined by the amount of heat or steam which is applied to expand the beads and the time the beads are exposed to this treatment. Typical steam pressures and times of exposure are shown in Table I, p. 110. Higher heat and longer heating times will produce more expansion and hence lower bulk density beads and vice versa, as can be seen in Table I. Production rates using higher pressure steam (more heat) will also be higher but there is more risk of the beads collapsing. The amount of heat and the exposure time may vary with materials from different suppliers for a given desired bulk density. Therefore, some experimentation will be required in order to determine the optimum expander settings.

Until very recently, commercial pre-expanders which could maintain the bulk density of the expanded-beads closer than ±4 oz./cu. ft. have not been available. This is because pre-expanders of prior design used no positive means for exposing each bead to the same amount of steam for the same amount of time. For automatic molding an expander was required which would ensure a closer control of the bead bulk density. Work on this problem at Miller & Van Winkle resulted in the development of the Millaspander. This pre-expansion machine consists of a large rotary drum containing pockets, similar to a water wheel, which are charged with a pre-determined weight of raw beads. The beads are then agitated under steam pressure for an accurately controlled time determined by the speed of the drum's rotation. The shape of the pockets containing the expanding beads, the angle, number and location of the steam jets which build up the pressure in these pockets, and the use of vacuum to remove steam and moisture, along with hot air, to stabilize the beads and other mechanical details make this machine a fully automatic, precision pre-expander.

With the newly designed expander it is now possible to maintain the bulk density of the pre-expanded beads within ±½ oz./cu. ft. over the range of densities from ½ lb. to 10 lb./cu. ft.

### Molds and filling devices

After the raw beads have been pre-expanded they are ready for molding. Usually the beads will be placed in an intermediate heated feed bin from which they can be automatically conveyed to the molding process. The production of the pre-expanded beads is tied in with the rate at which they are consumed in the molding operation and the production rate of the pre-

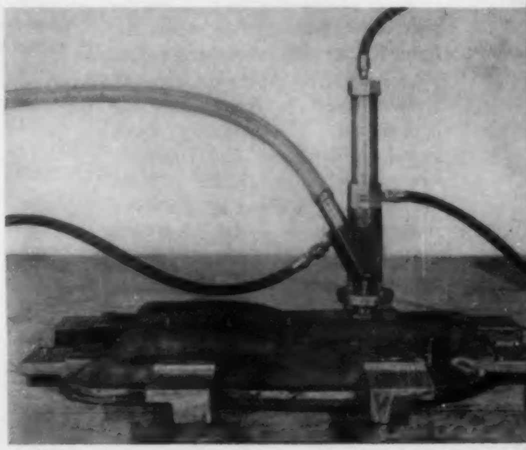


**FIG. 4:** Automatic foam mold filling device shown mounted on a mold.

**Table I:** Typical pre-expansion conditions for expandable polystyrene beads[a]

| Density | High steam pressure Pressure | High steam pressure Time of exposure | Low steam pressure Pressure | Low steam pressure Time of exposure |
|---|---|---|---|---|
| lb./cu. ft. | p.s.i.g. | sec. | p.s.i.g. | sec. |
| 2.0 | 20 | 10 | 10 | 16 |
| 2.5 | 16 | 9 | 9 | 14 |
| 3.0 | 14 | 8 | 8 | 13 |
| 3.5 | 10 | 7 | 6 | 12 |
| 4.5 | 8 | 6 | 6 | 11 |

[a]Data were developed using the Miller & Van Winkle Millaspander. Actual values will also vary with quality of the steam used, different manufacturers' expandable beads, and their propellant concentration.

expander is coordinated with the molding press. This serves to reduce the storage space required for pre-expanded beads. Also since the beads are already warm as they come from the pre-expander, the amount of steam required for expansion of the beads in the mold is reduced.

Molds for the production of polystyrene foam products must be constructed in such a way to allow for the injection of steam into the mold cavity for the final expansion of the foam. The mold must also be provided with cooling facilities to harden the foam product and with a means of ejecting the part from the mold. In automatic molding, part ejection should be positive to insure removal of the part from the molds prior to the next cycle. Also important in automatic operation is the ability to load the mold automatically, usually in the closed or almost closed condition. These various mold features are illustrated in Fig. 2.

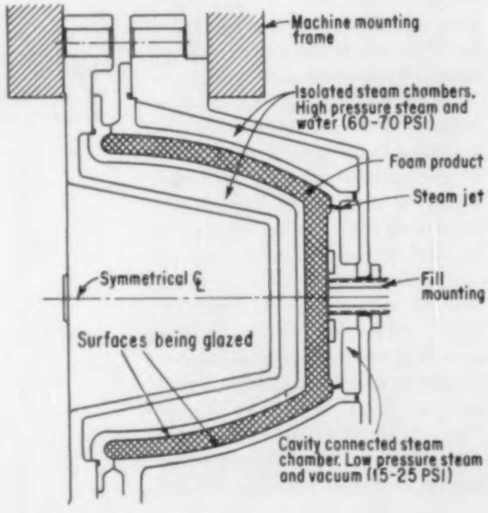
As to molds, it is only in the design of the cavity that molds for foam resemble molds used in other plastic processes. However, the wall sections used in foam parts are considerably thicker than those found in injection- and compression-molded items. Thicker sections are necessary because of the more frangible nature of the foam and the difficulty of uniformly filling very thin sections. Also, whereas a mold for an injection-molded item is made of a solid metal block in which the cavities are cut, the mold for an expandable foam part is usually hollow in construction. The hollow construction is required to provide for the distribution of steam to the mold cavity proper during the weld or foam fusion portion of the cycle, and to allow for the circulation of a large volume of water to cool the cavity after expansion of the foam. A typical mold for foam is shown in Fig. 3, p. 108.

With the exception of stainless steel, the use of non-ferrous materials for foam molds is almost mandatory, because of the corrosive nature of the steam and water used in the process. Originally, molds were made of aluminum, but now the trend is to bronze or stainless steel. Bronze molds are generally cast to reduce the amount of machining necessary to finish the mold. Molds of stainless steel are made by either the spinning or hydroforming metalworking processes. Wall thickness on the stainless molds runs from 60 to 70 mils and up. In bronze a minimum of 250 mils is used because of the difficulty of casting thinner sections. For long production runs and to prevent sticking, bronze molds are often chrome-plated. Up to now Teflon coatings have been used in aluminum molds for the same purposes and it was thought they might be used in steel and bronze molds used in automatic molding operations. However, although the Teflon coatings are extremely thin, they do slow down the cycle because of their lower thermal conductivity and are not recommended for molds that are used in automatic operations.

For the sake of keeping cycles to a minimum, the steam chamber on foam molds is contoured according to the shape of the cavity. This is done so that each area of the mold cavity is exposed to the same amount or volume of steam and water to achieve more uniform and rapid heating and cooling of the material being molded. It also conserves the use of steam as well as water.

To automate foam molding, it was obviously necessary to find a means of automatically loading the mold. The filling device developed (The Millafill) is attached directly to the mold as is shown in Fig. 3 and Fig 4, p. 109. In principle it is somewhat like the ball-check nozzle used on injection molding machines. It consists of a small air-operated cylinder in which a plunger acts as an on-off valve. When the plunger is in the molding

**FIG. 5:** Cross-section of a special foam mold that is used for the production of foam parts with highly glazed surfaces.



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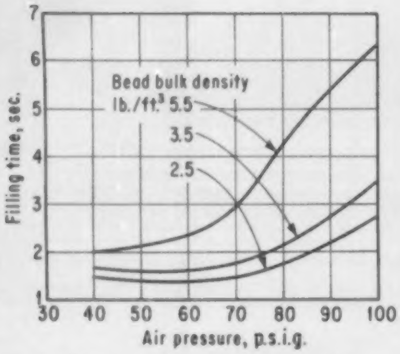



**FIG. 6:** Graph shows relationship between filling time and air pressure used to power the loading venturi for different bulk densities of pre-expanded foam in a given mold. Curves are typical and depend on the mold being used; however, shape of the curves is similar for different molds.

position, it is forward in the cylinder and the face of the plunger is flush with the face of the cavity, sealing off the feed tube leading to the mold. When the plunger is in its retracted mold-filling position, it allows material coming from a feed tube to pass through the cylinder and then into the mold cavity proper. See Fig. 3. The driving force sucking the beads from a feed bin and sending them into the cavity is dry compressed air. It must be dry air in order to prevent sticking of the beads to feed chutes and to the tubes.

A pneumatic system for loading the mold is necessary because of the light weight and compressibility of the pre-expanded beads. A ram cannot be used to stuff the beads into the cavity since any excessive pressure would tend to collapse the beads and could lead to erratic part density and uniformity.

As can be seen in Fig. 3 the device is very similar to the aspirators which are used as a source of vacuum in chemistry laboratories. A controlled jet of air is introduced at an angle in the material feed pipe. This creates a vacuum behind the jet which sucks the pre-expanded beads from the feed bin up to the air jet. After passing the jet, most of the air is bled out through slots on the filling device but enough air pressure remains to move the beads into the cavity. The balance of the compressed air coming from the jet bleeds out through the mold which is cracked open a few thousandths of an inch, during the filling cycle. When the mold is filled and resistance to further flow builds up the air forces any excess beads back into the feed bin. The loading device is so constructed that it can be simply unscrewed from one mold and used on another, in a matter of a few moments. See Fig. 4. It is presently supplied in six standard tube sizes ranging from ¼- to 1½-in. plunger diameters, which are deemed to be adequate for most mold-filling applications.

**Table II:** Typical cycle times used in automatic foam molding[a]

| Part wall thickness | Part density | Foam fusion[b] time | Cooling[c] time | Total[d] cycle |
|---|---|---|---|---|
| *in.* | *lb./cu. ft.* | *sec.* | *sec.* | *sec.* |
| 0.50 | 1.5 | 4 | 12 | 35 |
| | 2.5 | 5 | 16 | 42 |
| | 3.5 | 6 | 20 | 51 |
| | 4.5 | 8 | 25 | 68 |
| 0.75 | 1.5 | 10 | 20 | 51 |
| | 2.5 | 12 | 26 | 63 |
| | 3.5 | 12 | 34 | 75 |
| | 4.5 | 14 | 42 | 91 |

[a]Figures shown will vary with the design and geometry of the foam part but do indicate relative magnitudes. Data were obtained on Miller & Van Winkle Millatron molding press. [b]Time of exposure to full steam pressure. [c]Time that forced cooling is applied to expanded part. [d]Includes all times shown in addition to preheat and closing, filling and opening times.

### Automatic molding

After the molds have been loaded the actual molding operation begins. In the automatic molding press developed for this purpose (trade-named Millatron), the overall cycle is divided into the following six segments:

1. Preheating the mold.
2. Filling the mold.
3. Foam expansion with steam.
4. Time delay to allow the expanded foam to "set."
5. Full cooling with cold water.
6. Ejection of the part.

These steps are discussed in greater detail in the following sections of this article.

**Preheating the mold.** To minimize the accumulation in the foam of an excessive amount of water coming from the condensation of the steam used for expansion of the product the mold should be preheated. To save time, preheating of the mold is done as the mold is closing by means of steam at pressures up to 70 p.s.i.g. which are higher than those used for the actual foam expansion.

In addition to preheating the mold, this high pressure steam also forces any water from the prior cycle out through drains at the bottom of the steam chest. After a controlled time of about 2 or 3 sec. the drains in the mold are shut off and the full steam pressure is applied to the mold to complete the preheating. Since molds are mounted vertically in the molding press, any condensation on the face of the mold cavities drains away by gravity or evaporates.

The steam pressures used for preheating are too high for actual expansion of the foam in the weld or foam fusion step. Using a steam pressure higher than 40 p.s.i.g. in the mold cavity can actually cause the expanding foam to collapse. Therefore, a pressure regulating and reduction system was provided to supply low pressure steam for the actual foaming step.

**Filling the mold.** As soon as the preheat cycle is completed, filling begins. For fast and complete fill, the mold must be opened or "cracked" a small **(To page 180)**

# Trends in extruder design

A report on the latest developments in extruder components and how they contribute to optimum performance

By John Badonsky*

In recent years, those shopping for new extruders have undoubtedly noticed a large number of new designs reaching the market. These new designs are brought about by new resins, demand for higher production rates, the need to adapt extruders for use in new processes (such as blow molding), and the desire for easier maintenance and service (including readily available replacement parts at a reasonable cost to the customer).

The most critical extruder elements in this design picture are those which are subject to unusual loads, stresses, or abrasion and wear conditions: the cylinder, the thrust bearing, speed reduction components, as well as the speed-control unit itself.

Also requiring prime consideration are those components which, if inadequate, would compromise the extruder's performance. Among them are the heating and cooling system, the feed throat, and the extruder's base foundation which ties all the other elements together.

What has been accomplished to date in the design of these components to result in the best possible extruder performance?

### *Cylinders*

To withstand the abrasive action of the plastic materials passing through the tubular extruder cylinder, all barrels today are lined with a hard metal alloy. The special alloy liner may either be inserted and bonded as a separate shell or be integrally cast in place. The liner almost universally used today is centrifugally cast from an alloy called Xaloy or its cousin Xaloy 306. Because of the complexities of the process and practical production considerations, the cast liners are generally never produced in thicknesses below $\frac{1}{16}$ inch. Xaloys are hard but brittle. Because of this brittleness, the cylinder wall to which an Xaloy lining is bonded must be made relatively thick in order to keep mechanical expansion to a very low value and thus prevent cracking.

Two other alloys are used for barrel liners, namely, Stoody and Hastelloy. Both are more expensive than Xaloy and both must be installed as separate liners—they cannot be cast in place. Stoody is only slightly harder than Xaloy and is rarely used because of its cost. Hastelloy is used in equipment for extruding polyvinylidene chloride because it has better corrosion resistance than the other liner materials (polyvinylidene chloride sometimes breaks down in the extruder and liberates highly corrosive materials). However, Hastelloy is softer than Xaloy and is otherwise not generally used because of the expense involved. The softness of Hastelloy is such that care must be exercised in the insertion of the screw to avoid scratching the liner. For proper operation **(To page 119)**

* Chief Design Engr.-Extruders, Waldron-Hartig Div., Midland-Ross Corp., Mountainside, N. J.

Supplies and services: Xaloy and Xaloy 306 produced and cast into liners by Industrial Research Laboratories, Los Angeles, Calif.

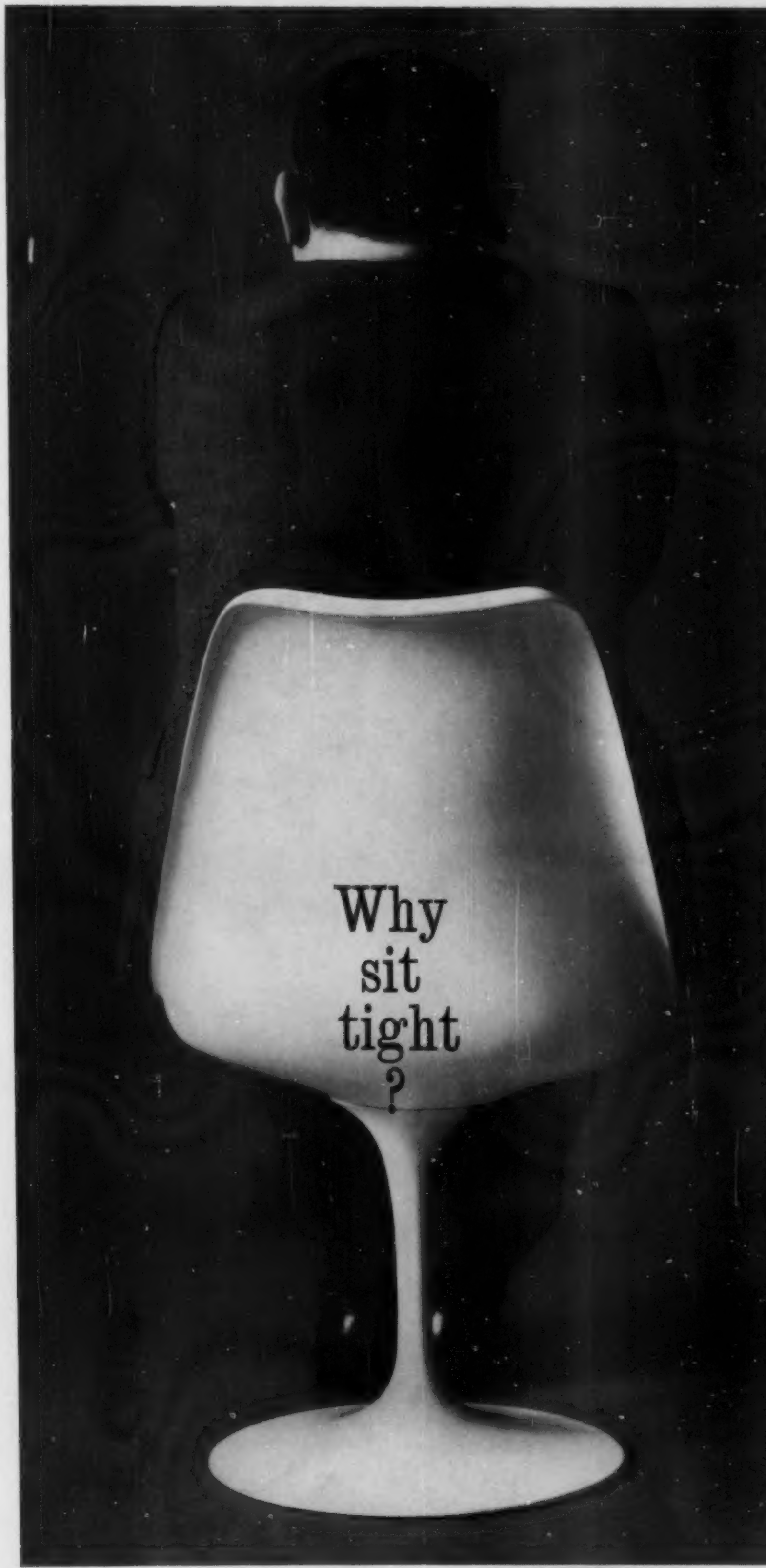
| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.25** | 1.6 | | | | | | | | | | | | |
| **1.50** | 2.2 | 1.4 | | | | | | | | | | | |
| **1.75** | 3.1 | 2.0 | 1.4 | | | | | | | | | | |
| **2.00** | 4.0 | 2.6 | 1.8 | 1.3 | | | | | | | | | |
| **2.50** | 6.2 | 4.0 | 2.8 | 2.0 | 1.6 | | | | | | | | |
| **3.25** | 10.6 | 6.8 | 4.7 | 3.4 | 2.6 | 1.7 | | | | | | | |
| **3.50** | 12.2 | 7.8 | 5.4 | 4.0 | 3.1 | 2.0 | 1.2 | | | | | | |
| **4.50** | 20.2 | 12.9 | 9.0 | 6.6 | 5.1 | 3.2 | 1.9 | 1.7 | | | | | |
| **6.00** | 36.0 | 23.0 | 16.0 | 10.8 | 9.0 | 5.8 | 3.4 | 2.9 | 1.8 | | | | |
| **8.00** | 64.0 | 40.9 | 28.4 | 20.9 | 16.0 | 10.2 | 6.0 | 5.2 | 3.2 | 1.8 | | | |
| **8.50** | 72.3 | 46.2 | 32.1 | 23.6 | 18.1 | 11.6 | 6.8 | 5.9 | 3.6 | 2.0 | 1.1 | | |
| **10.00** | 100.0 | 63.9 | 44.4 | 32.6 | 25.0 | 16.0 | 9.4 | 8.2 | 4.9 | 2.8 | 1.6 | 1.4 | |
| **12.00** | 144.0 | 92.0 | 64.0 | 47.0 | 36.0 | 23.0 | 13.6 | 11.8 | 7.1 | 4.0 | 2.2 | 2.0 | 1.4 |
| Screw diameter, in. | **1.00** | **1.25** | **1.50** | **1.75** | **2.00** | **2.50** | **3.25** | **3.50** | **4.50** | **6.00** | **8.00** | **8.50** | **10.00** |

**EXAMPLE**

**Problem:** What is relative output of 4.5-in. extruder compared to 3.5-in. machine. Screw design and L/D ratios are the same.

**Solution:** Find 4.5-in. extruder in vertical column at left—read across to 3.5-in. column on base of diagram. 4.5-in. extruder has approximately 1.7 times capacity of 3.5-in. extruder.

**FIG. 1:** Diagram for the comparison of relative capacities of commonly available sizes of extruders. Figures are approximate rule-of-thumb values based on the relationship in the equation on p. 119.

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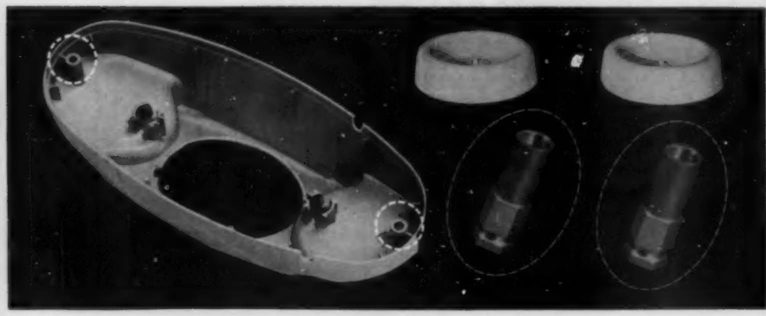
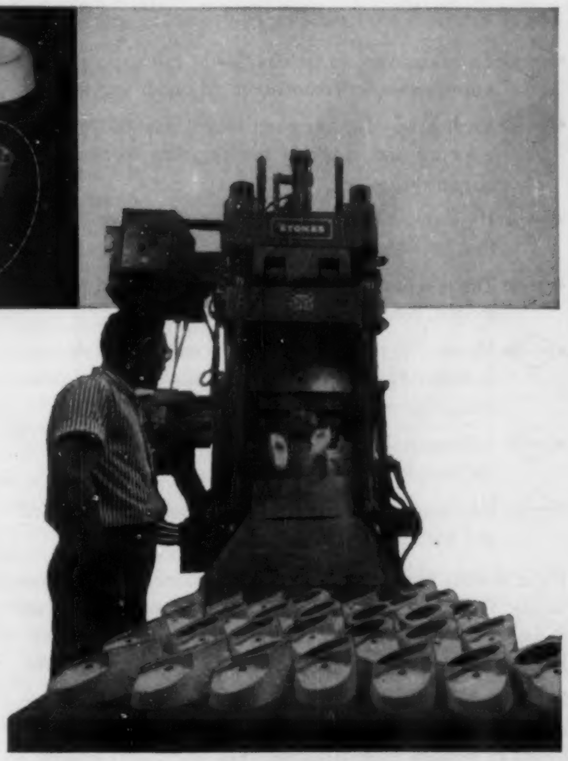


*The photo above shows the location of the metal inserts in the bottom of the housing. The transmitter and receiver caps shown here were also produced automatically. Unscrewing, degating, and separating of molded caps and runner systems are all accomplished with one operator attending several machines.*




*More than 20 motions and checking devices are incorporated in the Stokes 703 press. Metal inserts are bulk loaded, correctly oriented and metered to the loader. An automatic escapement device releases the inserts into a loading tray where they are checked. If the inserts are correctly positioned, the tray moves into the die area to drop the inserts into the mold. After the positioning of the inserts is again checked, the loading tray is retracted and the automatic injection molding cycle started.*

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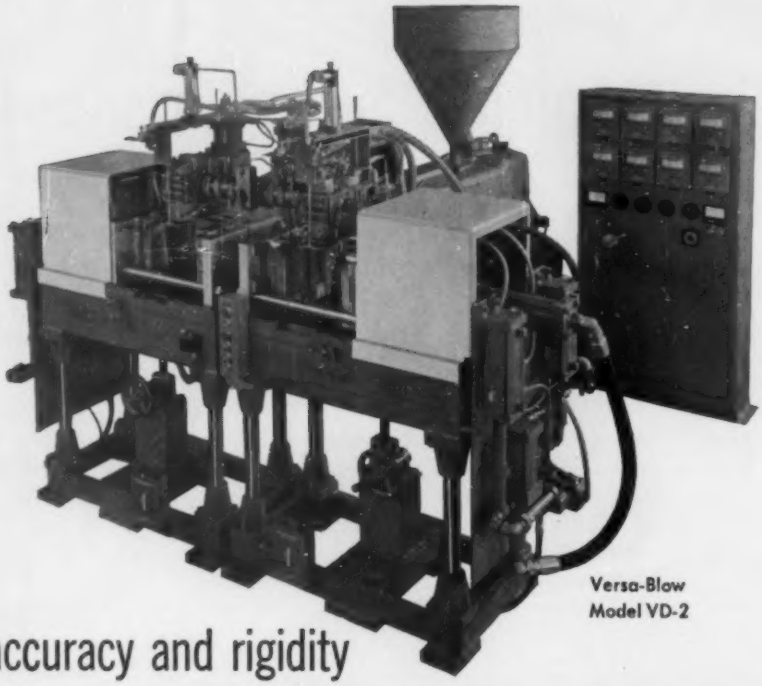

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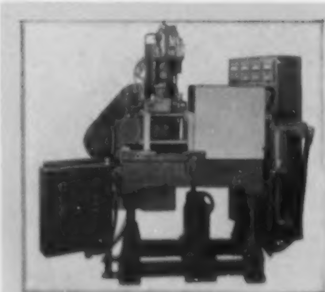

Flexible Versa-Blow series includes the single press Mod. VS-1

Producto's Magna-Blow series for giant products. Mod. M-1 shown.

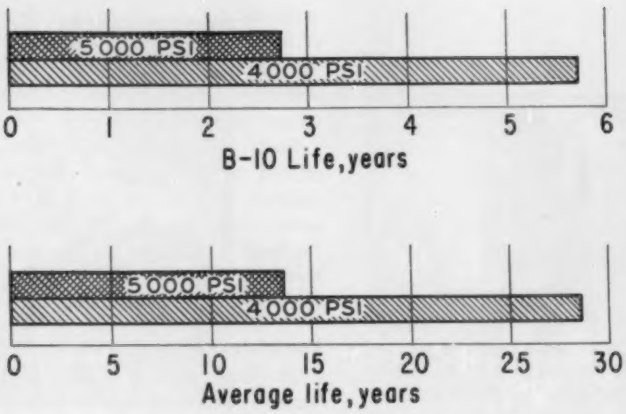


**FIG. 2:** Bar charts show the life expectancy of extruder thrust bearings in terms of B-10 life and average life (5 times B-10 life), (based on 307-day working year). Bearing life is determined by statistical analysis. Data is presented for both 4000 and 5000 p.s.i. bearing loads.

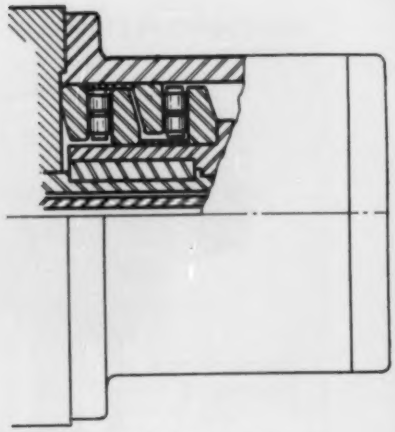

**FIG. 3:** Extruder construction that provides for the installation of an additional set of thrust bearings in the event they are required for extra-heavy-duty application exceeding the original rating of the extruder.

during extrusion the internal surface of the liner must be extremely smooth and blemish free. The diameter of the bore is usually held to a tolerance of $\pm 0.0005$ inch. Concentricity is held to $\pm 0.0005$ in. and the straightness of the bore is maintained at $\pm 0.001$ inch per foot of the length.

The tight tolerances are required because proper clearance of the screw is important in developing the full output of the extruder by minimizing backflow.

The output capacity of the extruder is also dependent to an extent on the absolute bore size or screw diameter. For extruders having similarly designed screws and the same L/D ratios, the outputs of two extruders may be expected to vary according to the rough rule-of-thumb relationship

$$\frac{C_2}{C_1} = \frac{D_2^{3}}{D_1^{3}}$$

where $C_1$ and $C_2$ are the relative outputs of the two extruders in lb./hr. and $D_1$ and $D_2$ are the respective screw or bore diameters of the two extruders. The output ratios

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The thrust bearing on a plastics extruder is the real "workhorse" of the machine. When one considers the magnitude of the force developed on the end of the feed screw and ultimately transmitted to the thrust bearing, it is obvious that extreme care must be used in the selection of this component. The force is easily calculated by multiplying the head pressure in p.s.i. by the projected cross-section area of the screw in square inches. In a 6-in. extruder this force can run up to approximately 270,000 p.s.i. on the bearing.

Fortunately, extruder manufacturers can call upon reliable bearing manufacturers to assist them in the study and selection of these components. However the final bearing selection is done by the extruder maker since the over-all performance of the machine is his responsibility. Most extruder thrust bearing assemblies use cylindrical-type roller bearings. Next in popularity are spherical roller bearings.

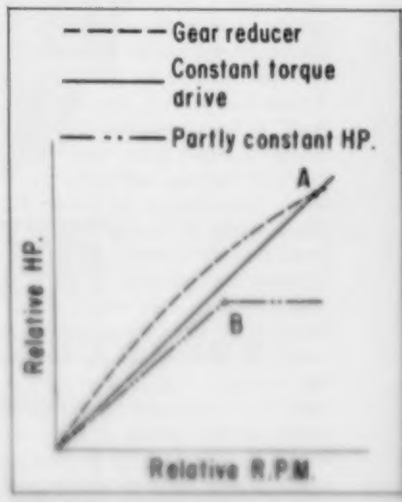


**FIG. 4:** Typical drive characteristics showing reference points for belt selection (*A* and *B*).

life expectancy figures for the bearings. A common reference point

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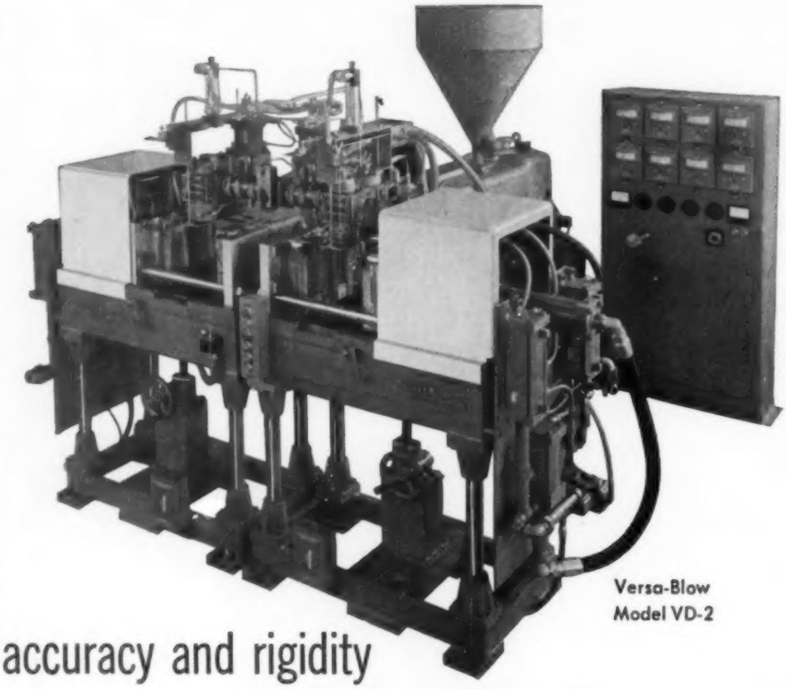

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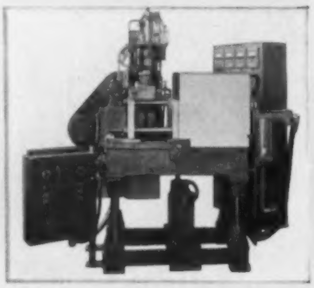

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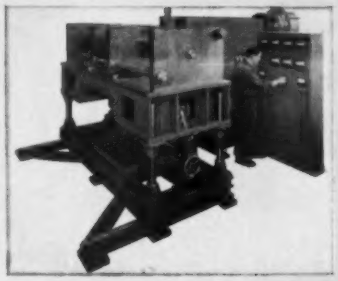

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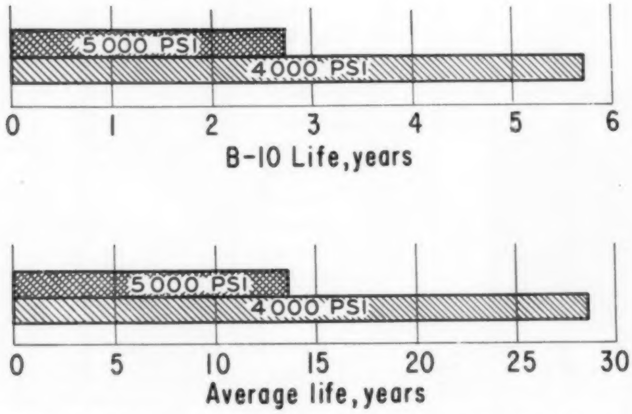


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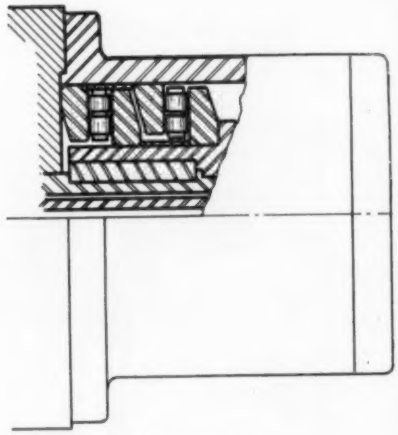

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where $C_1$ and $C_2$ are the relative outputs of the two extruders in lb./hr. and $D_1$ and $D_2$ are the respective screw or bore diameters of the two extruders. The output ratios of the commonly available extruders have been worked out and are shown in Fig. 1, p. 114. This compilation may be used for a rough comparison of the relative outputs for plastics extruders of varying sizes.

Because of the geometrical simplicity of an extruder barrel and the difficulty of finding new liner materials and processes for their installation in cylinders, no radical advances in barrel design are foreseen at this time.

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The thrust bearing on a plastics extruder is the real "workhorse" of the machine. When one considers the magnitude of the force developed on the end of the feed screw and ultimately transmitted to the thrust bearing, it is obvious that extreme care must be used in the selection of this component. The force is easily calculated by multiplying the head pressure in p.s.i. by the projected cross-section area of the screw in square inches. In a 6-in. extruder this force can run up to approximately 270,000 p.s.i. on the bearing.

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Since the life and deterioration of a bearing depends on dynamic fatigue failure rather than on simple static stresses and deflections, bearing manufacturers evaluate their product by means of statistical analysis. The results of these analyses are converted into

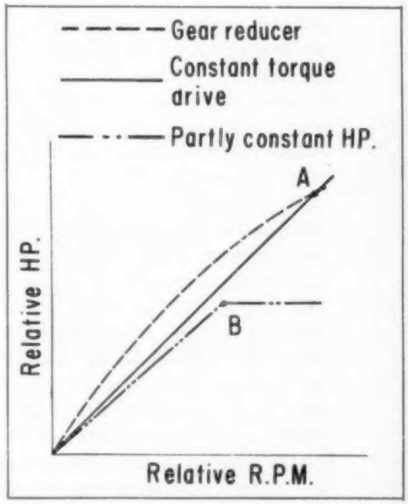



**FIG. 4:** Typical drive characteristics showing reference points for belt selection (*A* and *B*).

life expectancy figures for the bearings. A common reference point used in grading bearings is their B-10 life. This represents the expected minimum life of 90% of a random quantity of the bearings under test. The average life of the bearing is then estimated to be about 5 times the B-10 life.

Assume that an extruder is to operate with a design pressure of 5000 p.s.i. on a bearing that has a B-10 life of 20,000 hours. The ex-

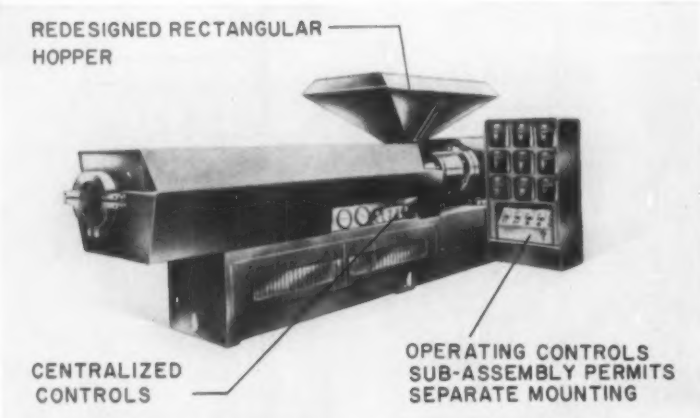



**FIG. 5:** Designer's rendering showing how redesign for esthetic reasons also resulted in larger capacity hopper and more operating efficiency through the centralization of controls.

truder, operating continuously (307 days/yr., 24 hr./day), will have one chance in 10 of requiring a replacement bearing in 20,000 hr. (2 yrs. and 7 mos.). However, there will be an even chance that the replacement will not be necessary until after 100,000 hr. (13 yrs. and 5 mos.) of service. On the other hand, if the continuous load is reduced to 4000 p.s.i., one out of every 10 bearings will probably require replacement in about 5¾ years, while an average life of 29 years may be expected. This relationship is graphically illustrated in Fig. 2, p. 119. The major significance of the data illustrated is that moderate increases in the load on the bearings, over that for which they were designed, can significantly lower bearing life. In the example above, a 25% increase in the operating pressure results in a 50% loss in the expected life of the bearings.

Special applications of extruders in severe service may require bearings with longer life expectancies, and extruder manufacturers sometimes provide enough flexibility in the bearing housing design to accommodate possible future bearing needs. Often this provision takes the form of a design which permits the use of bearings in tandem to reduce the net load on individual bearings. (See Fig. 3, p. 119).

### Speed reducers

Most extruder speed-reduction units consist of commercial gear sets, usually of the double-reduction type. And since it is desirable to transmit as much as possible of the total available horsepower to the screw, in order to get maximum output, herringbone and helical gear transmissions are usually preferred to worm gear reducers. Reduction ratios range from 15:1 to 30:1 and operate off motor speeds of 1800 or 1150 r.p.m.

A convenient reference point which may be used to help establish minimum reducer requirements is a realistic figure for extrusion rate per unit of power. A value of 6 lb./hr./hp. establishes a realistic extruder capacity for a given speed reducer when the basic extruder capacity is taken as 0.38 lb./hr./sq. in. of cylinder working surface, or 0.064 hp./sq. in. of working surface. If too much power is applied to the extruder screw, it may conceivably break the feed screw under some conditions, e.g. a "cold start." The thermal capacity of the gear transmission unit must also obviously be able to handle the power being transmitted to the screw. Heat generated in the transmission is often great enough to warrant the use of cooling water circulating in coils in the transmission.

With users of extruders always striving for the highest possible production rates, it is frequently necessary to alter the speed range of the transmission beyond the original range provided. For this reason, most extruders are equipped with V-belts. An increase in speed or increase in torque can be achieved economically by changing pulleys or belts. A secondary advantage of the belt and pulley system is the ability to provide special speed ranges on short notice.

Some extruders now being offered in the market are constructed so that the gears in the speed reducer itself may be changed to achieve various combinations of speed and torque to suit varying extrusion conditions.

### Variable-speed drives

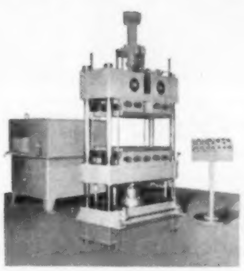
The most popular type of unit, because of its economy, is the variable-pitch-diameter pulley. While these units are suitable for the control of screw speeds when the power transmitted is 75 hp. or less the economic advantage is dubious in sizes above 30 hp. The motor is usually an integral part of the unit. Drives of this type are classified as having partly constant horsepower and partly constant torque. (See Fig. 4, p. 119). But they typically deliver constant horsepower throughout the speed range whenever unusual load conditions develop (without affecting motor overload protection). It is, therefore, possible to break screws at low speeds if extreme overloads develop. The over-all speed range usually varies from 7:1 to 3:1, depending on size.

A second type of speed control consists of a variable-speed d.-c. motor, the speed of which is controlled by a rectifier-controller. This control is commonly assumed to be the most sophisticated type of control unit. It is the most expensive of the three types most frequently used and is available with purely constant torque characteristics or in partly constant horsepower variations. The latter variation is the one most often found on extruders in the field operating with the rectifier-controlled d.-c. motor. The over-all speed range of such units usually varies from 8:1 to 16:1 depending on the control unit.

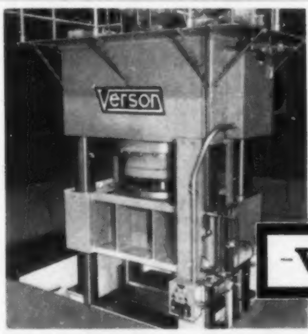
The third-most popular unit is the constant torque magnetic (slip) coupling type driven by an a.-c. motor. It is intermediate in cost between the two units mentioned above. Compact in construction, the slip coupling and the motor are integrally mounted in the same housing. This control may require a generous supply of cooling water to dissipate the (To page 190)


Giant 1000 ton Verson down-acting hydraulic fiberglass molding press. Working area is 100" x 192".

150 ton Verson up-acting hydraulic reinforced fiberglass molding press. Working area is 50" x 74".

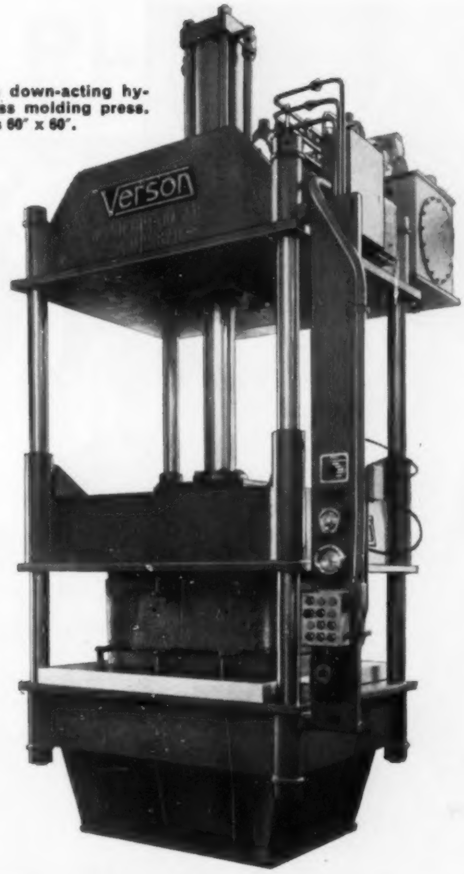


50 ton Verson up-acting hydraulic transfer molding press. Working area is 12¼" x 36".




600 ton Verson down-acting hydraulic compression molding press. Working area is 48" x 60".

150 ton Verson down-acting hydraulic fiberglass molding press. Working area is 60" x 60".

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MATERIALS • PROPERTIES • TESTING METHODS AND INSTRUMENTATION • STANDARDS • CHEMISTRY

# Shrinkage of glass-reinforced polyesters

By Herman V. Boenig† and Norman Walker†

Causes of shrinkage occurring in glass-reinforced polyesters are reviewed. Examination of these factors indicates that both chemical and thermal shrinkage may very well be major determinants responsible for the formation of the fiber attachment often referred to as "reinforcing bond." Detrimental shrinkage phenomena are discussed in the light of presently available information.

Volume changes are of great importance in the manufacture of glass-reinforced polyester products. They can occur during the three main phases of the curing process: pregelation, molding, and postcure. In all three cases the total volume changes are generally negative, *i.e.*, they result in shrinkage.

The main portion of the chemical shrinkage in the mold can be eliminated by pregelling the wet lay-up prior to molding. The volume changes that occur during the molding cycle have been demonstrated by McGlone and Keller (1)[1]; they take place as follows:

1. Compression of the plastic (volume reduction).
2. Material expansion due to heat from the mold and heat generated exothermically (volume expansion).
3. Volume reduction due to polymerization of the material.
4. Volume expansion due to the opening of the press and the consequent decompression of the molded piece.
5. Volume reduction due to removal of the part and its subsequent cooling.

Some of these events, of course, overlap or take place concurrently. McGlone and Keller (2) employed a punch-travel method to demonstrate these events. Using a glass-filled alkyd in an unlanded mold they recorded the travel of the punch over the period of the molding cycle, Fig. 1, below.

While it is true that an unlanded mold is rarely used in this industry, the typical volume-change pattern obtained would be expected to apply to most types of compression molding when the material is not pregelled prior to mold closure. If pregelling is employed, the total punch travel would be greatly reduced and the variation in the punch travel would be smaller, depending on the pressure applied and the mold temperature.

The decompression and resulting spring-back of the molding, which occurs when the molding pressure is released, is usually small in relative magnitude. But the increment of thermal shrinkage is most important as one can readily estimate from the thermal expansion coefficient of the molded material. An accurate calculation, however, is not possible without including other determinants, such as the evolution of gases during the cooling period and the rate of cooling. In particular, the increase in the amount of shrinkage with increase in the cooling rate is a phenomenon that is not yet fully understood.

Shrinkage can also occur on postcure, *i.e.*, after the piece is cooled, by postbaking, weathering, aging, etc. This effect can become quite significant if the piece is insufficiently cured in the press.

While the aforementioned shrinkages of the molded or laminated products are understood as total volume shrinkages, there are types of locally confined shrinkage that are equally important and have caused considerable concern to both the resin manufacturer and the molder. They are manifested

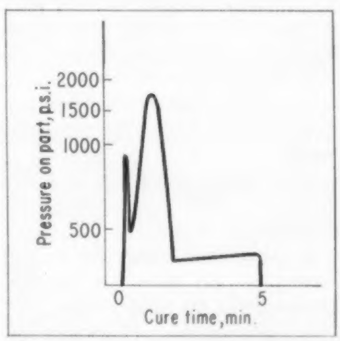



**FIG. 1:** Pressure curve during cure of glass-filled alkyd molding compound (2)[1].

*Reg. U. S. Pat. Off.
†Director and staff member, respectively, Research and Development Dept., Brookpark, Inc., Cleveland, Ohio.
[1]Numbers in parentheses designate references at end of article, p. 203.

**Table I:** Shrinkage of polyester molding compounds from cold mold dimensions (reference 3)

| Type of polyester molding compound | Mold temp. | Cure time | Shrinkage | Pressure |
|---|---|---|---|---|
| | °F. | sec. | in./in. | p.s.i. |
| Mineral-filled putty | 320 | 11 | 0.004 to 0.007 | 800 |
| Mineral-filled granular | 320 | 11 | 0.004 to 0.007 | 1500 |
| Modified mineral-filled granular | 325 | 13 | 0.005 to 0.008 | 1500 |
| Glass-reinforced | 320 | 20 | 0.002 to 0.004 | 2000 |

in phenomena such as crazing, fiber prominence, internal fiber blush, warpage, porosity, waviness of the surface of the molded piece, and air occlusion. While there are many determinants for such defects, their main causes appear to be non-uniformity of constituents and high rates of reaction.

Uniform shrinkage at reasonable rates is not detrimental. On the contrary, there is strong evidence to show that shrinkage contributes to quality, especially the strength, of glass-reinforced polyester laminates. Moreover, there is evidence that the magnitude of the "reinforcing bond" or of the "frictional attachment" between resin and glass is largely caused by both chemical and thermal shrinkages of the resin. The glass-reinforced types of compression moldings will exhibit shrinkages from cold mold dimensions in the range of 0.002 to 0.004 in./in. and the mineral-filled types in the range of 0.004 to 0.008 in./in. (Table I, above).

### Terminology

**Molding shrinkage.** This is the difference between the corresponding linear dimensions of the mold and of the molding at room temperature. Molding shrinkage is the result of a number of factors (4):

1. Volume changes due to elastic or plastic decompression when the mold is opened and the piece removed.
2. Chemical shrinkage or polymerization shrinkage. "Apparent chemical shrinkage" (1).
3. Directional effects due to the orientation of fillers or to the "memory" of the filled system.
4. Entrapment or evolution of gases during molding and their loss after molding.
5. Thermal shrinkage after cure (5). This is a function of the ejection temperature of the molded piece and the thermal expansion coefficient.

The molding shrinkage factor can be calculated from both the mold dimensions and the part dimensions measured at room temperature (1). The shrinkage can also be obtained from the difference in density between the liquid and the cured resin (6).

**Postcure shrinkage.** This shrinkage occurs after the piece has been removed from the mold and placed under postcure conditions, *e.g.*, heat, irradiation, weathering, etc. Storage at ambient temperatures is also found to result in shrinkage of the molding, which may be caused by slow-rate reactions via residual peroxides, internal stresses, etc.

**Table II:** Shrinkage behavior of various monomers used in polyester molding compounds.

| Monomer | Shrinkage of polymer |
|---|---|
| | % |
| Vinyltoluene | 12.5 |
| Styrene | 16 |
| Diallyl phthalate | 18 |
| Methyl methacrylate | 24 |

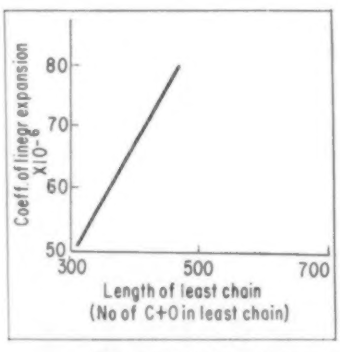



**FIG. 2:** Relation of thermal expansion to least-chain length (Reference 13).

**Negative shrinkage** or growth of the piece is usually due to excessive decompression of a piece that was under high pressure but heated under moderate temperatures. It is very likely to occur in the vertical direction (1).

**Shrinkage dependence on the rate of cooling.** If the piece is removed quickly from the hot mold and placed immediately under low-temperature conditions, it is found that the molding has a higher density than a piece that is cooled at a slow rate. The mechanism of this phenomenon has not been explained. It may be connected with a skin effect, *e.g.*, the quick thermal contraction of the outer area causing a high internal pressure.

**Linear shrinkage** is determined from the volumetric shrinkage by dividing the volumetric shrinkage by three (7). If, for instance, a hypothetical cube of 100 units on an edge is shrunk 6% in volume, the linear change will then be 2% or to 98 units on an edge.

**Pregel shrinkage** relates to practices where the "wet sheet" is pregelled before being placed in the mold or the press. In such a process the main portion of the shrinkage occurs outside the mold.

**Shrinkage pool** (8) relates to an irregular, slightly depressed area on the surface of the molding. It is caused by uneven shrinkage before complete "hardening" is attained.

### Variables affecting shrinkage

**Degree of unsaturation of the polymer.** The shrinkage, as contributed by the alkyd portion of the resin, depends mainly upon the number of crosslinks formed, the degree of linear polymerization, and the steric structure of the polymer. Although, theoretically, the amount of chemically reactive unsaturation can be varied within wide limits, a high-quality resin requires that the number of monomers reacting with the polymeric unsaturation should be about the same at both the start and the end of the reaction. In other words, an optimum polyester system is obtained when the ratio of monomer

to alkyd double bonds is about 1:1 (9, 10, 11). It is uncertain whether this also applies to systems containing methyl methacrylate, since this monomer has been reported (12) to have a lesser ability than styrene to copolymerize with polyesters. It is likely that all of the unsaturated acid residues are employed in crosslinks (13) *i.e.*, contribute to chemical shrinkage, provided the monomer: maleic (or fumaric) ratio is about 1:1 or even higher.

**Length of polymer chain.** Wood (13) recently showed that the linear coefficient of expansion of cured polyesters is proportional to the "least-chain length," a measure of the length of the polyester backbone (Fig. 2, p. 124). Accordingly, the thermal shrinkage of polyesters should increase with the degree of polymerization of the polymer formed. The definition of "least-chain length" of the polyester (not containing monomers) was given as $\Sigma xz$, where $x$ = least chain length of a component and $z$ = mole percentage of this component. Wood concluded that "since the segments of the polyesters with longer least-chain lengths are freer to move (even after crosslinking) than the segments of shorter least-chain polyesters, they will occupy more volume on heating," and, accordingly, will result in a larger volume reduction on cooling (thermal shrinkage).

Shrinkage of the resin is also influenced by the chemical and steric structure of the polyester backbone, *i.e.*, by factors such as the flexibility of the links along the chain, the type of diol employed (aliphatic or aromatic), the concentration of the resin, and the type and length of pendant groups present. For example, substitution of propylene glycol in the polymer chain by hydrogenated bisphenol A results in a substantial reduction in the shrinkage (6).

**Monomers.** The percent shrinkage of crosslinking monomers used commercially in polyesters varies greatly, as shown in Table II, p. 124. Styrene, which is the monomer employed most widely in polyester-monomer systems, causes the shrinkage to increase linearly with the concentration. The shrinkage of three different polyesters is plotted against the styrene content of each in Fig. 3, above. The molar composition of these three polyesters is shown in Table III, below. The greater contribution of methyl methacrylate to the shrinkage of polyesters is demonstrated in Fig. 4, p. 128.

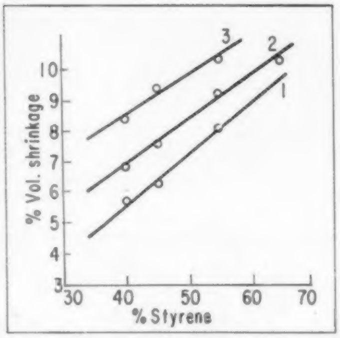



**FIG. 3:** Shrinkage versus styrene content of three polyesters (Reference 6).

**Reinforcing fibers and fillers.** The shrinkage of polyesters is reduced as the amount of glass and/or filler is increased. The effect of glass fibers is shown in Table IV, p. 128. It is evident that the greatest shrinkage decrement is obtained by the addition of approximately the first 8% of glass fiber. The length of the glass fibers does not appear to affect shrinkage to any significant degree (Fig. 5, p. 131).

Fillers reduce the shrinkage. Since they do not shrink, the shrinkage of a filled system is usually that of an unfilled polyester decreased by the volume percentage of the filler.

In many cases, the orientation of the filler influences the amount of shrinkage and also the shrinkage direction of a molded piece. In general, the thermal shrinkage of most of the thermosets that have been studied is larger in the direction of the pressure than perpendicular to the pressure. This is believed to be due to the orientation of the filler and also due to the difference in the thermal shrinkage between filler and resin. On repeated heating and cooling of the piece the thermal expansion coefficient is reduced. This is probably due to postshrinkage. The resin nearest to the filler or glass will cool faster and therefore shrink more quickly. The resin farther away will cool more slowly and, therefore, shrink more slowly. But the resin farther away will reach a higher exothermic peak which may result in higher actual shrinkage. This may cause cracking in resin-rich areas (16). The order of magnitude of either of these two opposing effects will, of course, determine the overall shrinkage, or the creation of internal stresses.

**Molding pressure.** Generally shrinkage is reduced as the molding pressure is increased. The shrinkage of some thermosetting materials at two different molding pressures is compared in Table V, p. 128. While pieces molded at higher and lower pressures may shrink about the same amount during cooling, those molded at higher pressures are initially larger when the mold is opened due to higher elastic expansion of the piece. If the rate of cure at higher pressure is greater, the increment appears to be of small significance as compared with the greater elastic expansion of the molded piece. Similarly, the shrinkage is decreased as the mold design approaches "fully positive" due to the greater "effective" pressure.

**Mold temperature.** Usually the shrinkage is found to increase with the mold temperature. This is essentially due to the higher ejection temperature, higher exotherm, and higher rate of reaction. In glass-reinforced polyesters **(To page 128)**

**Table III:** Composition of polyesters (See Fig. 3)

| Polyester type | Moles of component[a] | | | | |
|---|---|---|---|---|---|
| | *HBPA* | *PG* | *PA* | *MA* | *FA* |
| 1 | 2.4 | — | 0.5 | 1.5 | — |
| 2 | 1.5 | 1.5 | 0.5 | 1.0 | 1.0 |
| 3 | — | 2.4 | 1.0 | — | 1.0 |

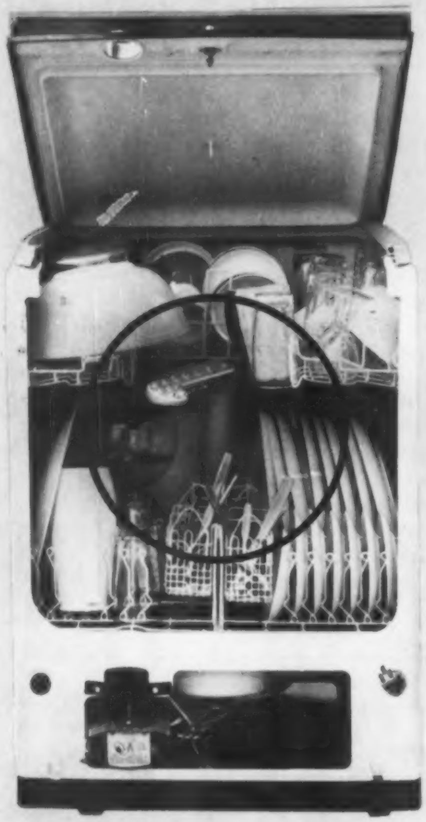
[a] Key to components: HBPA = hydrogenated bisphenol A (MW = 240.4); PG = propylene glycol (MW = 76.1); PA = Phthalic anhydride (MW = 148.1); MA = maleic anhydride (MW = 98.1); FA = fumaric acid (MW = 116.1).

HERCULES Plastics Hi-lites

# Never Before in Plastics

## *Three pioneering designs in diverse markets point up the versatility of Pro-fax® polypropylene.*

It goes without saying that in big ticket items, producers can't gamble on any part designed to play a key functional role. Whatever material they may plan to use they test it exhaustively, especially if it is plastic. These are not gadgets or novelties, but top-flight, high-quality merchandise. Pro-fax had to be good to even merit evaluation in such big, hard-to-do jobs. The fact that it won them all over all other materials points to a range and depth of performance no other thermoplastic can match. Never before in plastics . . . and never were the jobs done so well: functionally, esthetically, and economically.

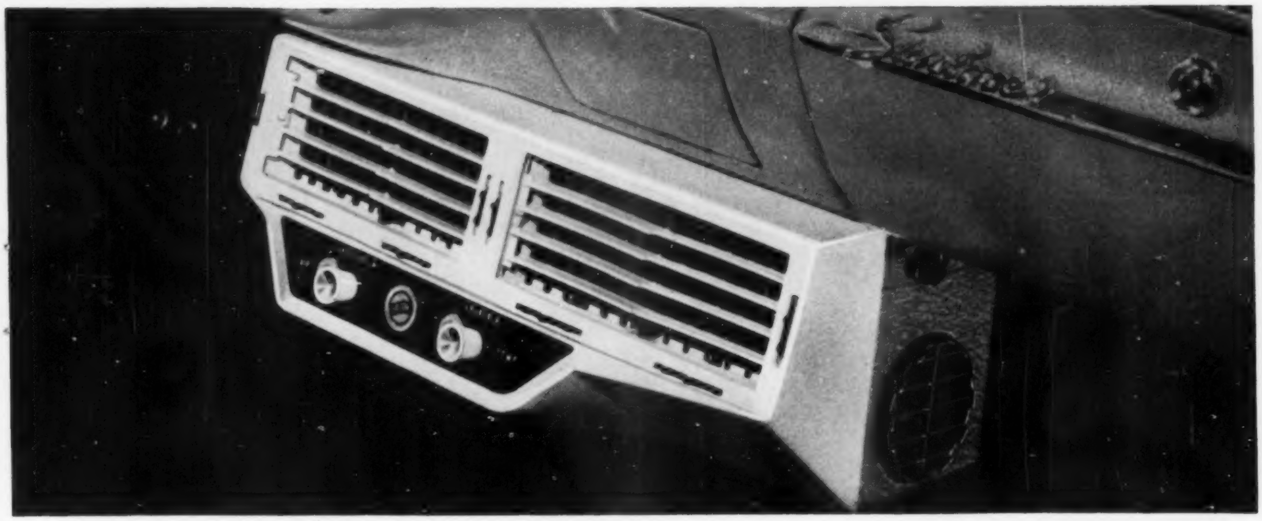


Molded by Industrial Molding Corporation, Culver City, California. Tubing extruded by Plastic Process Company, Los Angeles, California.

The heart of any automatic dishwasher is the water distribution system which provides the washing and rinsing action. Waste King uses Pro-fax for the unique rotating Z-arm of its new Universal dishwasher to provide improved washing action, increased capacity, and permit genuine "random loading." In operation a powerful pump forces water through scientifically located openings on the rotating arm into a spray which reaches into all corners of both the upper and lower baskets. Dishes, silverware, and pans are thoroughly washed and rinsed, regardless of their position in the machine.

Here's a job that makes real demands on a thermoplastic. Heat and stain-resistant, immune to stress-cracking from detergent attack, and possessed of the structural strength required to withstand the centrifugal forces set up by the rotating action, Pro-fax met every requirement.

Z-arm of Waste King dishwasher is constructed from injection-molded Pro-fax parts welded together to form this complex unit. Its through-and-through color can't wear off, rust or corrode.



## FUNCTION AND ECONOMY BOTH HINGE ON PRO-FAX

The hinged deflectors for this new auto air-conditioner are all molded with Pro-fax, in a design which replaces many metal parts with a few attractive, durable plastic components. The unique ability of Pro-fax to replace a conventional metal assembly with an integrally molded hinge enabled Eaton Manufacturing Company to cut over-all costs more than 65% and at the same time achieve a weight saving of more than 90%. The completed Pro-fax assembly won't rattle or squeak, requires no lubrication, and has a glossy surface finish with high resistance to grease, oil, and ultraviolet light.

More and more new product designs such as this hinge won the selection of Pro-fax for improved function and reduced manufacturing costs.

*Molded by Port Erie Plastics, Erie, Pennsylvania, for Eaton Manufacturing Company, Cleveland, Ohio.*

## FOR THE FIRST TIME . . . INJECTION MOLDED LUGGAGE

In luggage, too, Pro-fax® now does a job no material ever handled so well. Sears describes its new line of FORECAST luggage, injection molded with Titanite (*Hercules Pro-fax*), "the greatest step forward in luggage since leather." And for several good reasons. Extensively pre-tested before marketing by the world's largest merchandisers, FORECAST luggage, with exclusive Titanite shell, survived 2,000 tumbles in a mechanical package testing wheel (equivalent to a lifetime of use) where all other types failed after going only 1/5 the number of turns in the tumbler. It survived 500,000 miles of actual travel-testing with but a few scuff marks which were readily removed. One of the lightest molded cases available, its owners will recover its initial cost in savings in air travel excess weight charges. The excellent chemical resistance of Pro-fax makes it virtually immune to staining. Here's luggage you can scrub in the tub after travel dirt accumulates, and restore to its original rich, attractive finish.

Molded with a special formulation of high impact Pro-fax, it is strong, tough and resilient. Aptly named FORECAST, it's your first look at what will soon be the new look in many product lines where large shapes, injection molded with Pro-fax, will serve to bring new functionality and merchandising values to industrial and consumer goods.

*Molded by Amos Molded Plastics, Edinburg, Indiana, for Sardis Luggage, Sardis, Mississippi. Exclusively distributed by Sears, Roebuck and Company, and available now in the Sears catalog and selected retail stores throughout the nation.*

*HERCULES POWDER COMPANY*
INCORPORATED
*Hercules Tower, 910 Market Street, Wilmington 99, Delaware*

HERCULES

THREE NEW MATERIALS FOR THE PLASTIC INDUSTRY.

CP60-17

HI-FAX® HIGH-DENSITY POLYETHYLENE • PRO-FAX® POLYPROPYLENE • PENTON® CHLORINATED POLYETHER

there is an optimum mold temperature for a given set of conditions. This is a compromise between the requirements of limiting postcure effects, reduction of cure time, uniformity in shrinkage, optimum surface appearance of the piece, weather resistance, and physical properties required for strength. If the temperature of the force differs too greatly from that of the cavity, uneven shrinkage will occur. If the mold temperature is too low, postcure shrinkage effects may become predominant. Moldings polymerized at room temperature have the advantage of more uniform shrinkage.

**Cure time.** Increasing cure time causes the thermal expansion coefficient of the material to be reduced (and thus the thermal shrinkage). This initially results in a larger piece after its release from the mold because the longer cure time causes greater elastic recovery after the pressure is released. McGlone and Keller (2) demonstrated the changes of actual pressure on the part during the molding cycle (Fig. 1). Thus, after 5 min. cure time, the pressure on the part is nearly nil.

**Mold design.** Mold design factors, such as the degree of positivity of the mold, the thickness of the piece, and the depth of draw affect the amount and direction of the shrinkage of the polyester. As the mold approaches "fully positive," the effective pressure on the part becomes greater. On opening the mold, the elastic recovery of the piece is greater. The depth of draw effects a reduction in shrinkage from top to bottom of the draw. Increasing the thickness of the piece causes shrinkage to increase due to higher exotherm. Also important is the type of "cut off." This includes the loss of resin at a zero "cut off." Generally speaking, from the point of view of shrinkage, the effects of piece thickness and positivity of the mold usually predominate.

**Piece cooling rate.** The shrinkage of polyester laminates increases with the rate of cooling. The highest shrinkage takes place when the piece is immersed in a cold bath immediately after removal from the press. Thus, in view of the correlation between shrinkage and specific gravity, a piece of higher density is formed if the molded product is quenched after ejection of the part. This mechanism has not yet been explained.

**Exotherm.** As would be expected, the shrinkage increases with the exotherm peak. The exotherm is controlled by several parameters, such as the percentage of curable unsaturation in the polymer, the type and amount of monomer, the molding temperature, the type and percentage of catalyst, the molding pressure, the uniformity of glass distribution, and the thickness of the piece. Table VI, p. 131, gives the relationships between the exotherm peak, the percent curable unsaturation in the polymer chain, and the amount of styrene. The highest temperature increments are found by increasing the polymer unsaturation from 20 mole % to 40 mole % maleic anhydride. The contribution of the styrene to the exotherm peak is seen to be much smaller at a relatively low degree of polymer unsaturation. Substitution of part of the styrene by methyl methacrylate is not expected to change the exotherm peak temperature greatly since the heat of polymerization of these two monomers is about the same. But the shrinkage will be higher as the methyl methacrylate portion is increased because the shrinkage of the latter is 50% greater than that of styrene.

If the exotherm peak is too high, shrinkage may become excessive and will cause cracking, fiber prominence in the surface, internal fiber blush, and shrinkage pools. This will result in low strength properties and reduced water resistance. When spraying thick sections in short periods of time, the exothermic heat will rise very quickly (18). Warpage is often an addi-

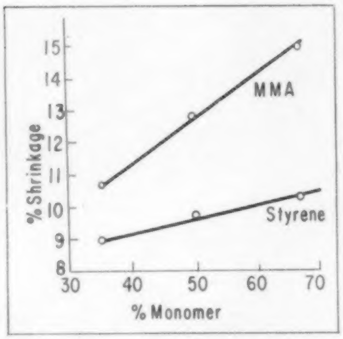



**FIG. 4:** Relative effects of styrene and methyl methacrylate on shrinkage of a polyester (Reference 14).

**Table IV:** Effect of amount of ¼-in.-long glass fiber in polyester molding compound on shrinkage (reference 15)

| Amount of glass fiber | | Shrinkage, in./in. | |
|---|---|---|---|
| *Vol. %* | *Wt. %* | *2-in. disk* | *6-in. bar* |
| 0 | 0 | 0.014 | 0.0085 |
| 6.3 | 7.6 | 0.006 | 0.0031 |
| 10.5 | 12.7 | 0.004 | 0.002 |
| 15.5 | 19.1 | 0.0043 | 0.0013 |
| 21.0 | 25.4 | 0.003 | 0.0007 |
| 26.0 | 31.8 | 0.002 | 0.0005 |

**Table V:** Effect of molding pressure on shrinkage of thermosetting materials (reference 5)

| *Material* | Shrinkage | |
|---|---|---|
| | *At 4000 p.s.i.* | *At 6000 p.s.i.* |
| | % | % |
| Heat-resistant phenolic | 4.9 | 4.3 |
| Mineral-filled polyester | 4.9 | 3.6 |
| Mineral-filled silicone | 6.1 | 5.0 |
| GP one-step phenolic | 7.5 | 6.7 |
| GP two-step phenolic | 8.5 | 7.2 |

tional defect connected with such excessive shrinkage.

**Charge weight.** As McGlone and Keller have shown (1) "the effect of increased charge weight and the corresponding increased mold-part weight on the molding shrinkage of parts molded in a landed mold is similar to the effect of increasing the pressure on the part. Also, on opening the mold the decompression is greater, thereby resulting in reduction of the total thermoset shrinkage."

**Evolution of gases.** Gases may be evolved during the curing process even if the process conditions are right. Progressive shrinkage has a tendency to help force gases to the surface. If such gases are released immediately on the opening of the mold and the cooling of the part, the shrinkage will be increased by part of the volume the gases have occupied inside the reinforced system. Measures aimed at the prevention of such evolution of gases are: evacuation of the resin prior to fiber impregnation, gasketing of the mold, elimination of moisture by the proper storage of raw materials, reduction of both molding temperature and catalyst concentration, and retention of molding pressure until completion of cure.

### *Defects caused by shrinkage*

Many variations in quality that occur in glass-reinforced polyesters are caused, wholly or in part, by uneven or excessive shrinkage. The polyester resin has a much faster cooling rate and shrinks to a far greater extent than does the glass fiber. The thermal expansion coefficient of the polyester is about 10 to 20 times that of the glass fiber. Furthermore, during the cure heat is generated only in the resin and must be conducted into the material adjacent to the resin, *i.e.*, glass fibers, fillers, or the mold itself. As has been pointed out, the resin in the area of these interfaces will cool more quickly (and therefore shrink more quickly) than does the resin further away from these interfaces. In addition, the resin that is further away from these interfaces will reach a higher exotherm temperature. These conditions are effective initiators for the formation of internal stresses, which are amplified by the fact that the higher rate of cooling increases the actual shrinkage of the polyester, resulting in a resin of greater density. The overall result will be that stress gradients are built up within the cured molding or the laminated products. These stress gradients may be injurious to the quality of the products. On the other hand, there is evidence indicating that some stress between the resin-glass interface contributes greatly to the increased strength of the laminates.

**Air, air pockets, air interfaces.** Glass-reinforced cured polyester systems may contain air or gas in the form of bubbles or in the form of linear separations between cracked resin-resin, or resin-glass interfaces. Air or voids are often encountered when the rate of heating (exotherm) is too great. Monomers will partly evaporate or release dissolved air. The resulting gases will then be occluded in the fast-shrinking polymer and will appear in the form of bubbles, air pockets, or "voids." There are a number of methods which will prevent such air occlusions: evacuating the resin or monomer prior to layup, adding the monomer to hot resin, preheating the resin prior to fiber impregnation, increasing the wet-out time, or heating the mold at a slow rate. Also, high molding pressure and the use of gaskets can prevent the formation of air bubbles due to the well-known pressure-volume relationship of gases and also the higher solubility of gases in the monomer with increasing pressure. The use of gaskets in the mold or matched metal molds will often reduce the occurrence of air bubbles and voids.

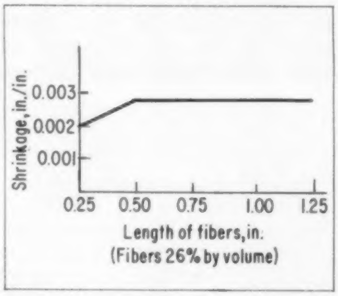



**FIG. 5:** Fffect of length of glass fiber on shrinkage of polyester molding compound.

**Crazing, cracking, internal fiber blush.** These defects are usually due

**Table VI:** Effects of maleic anhydride and styrene content of polyester resin on exotherm peak (reference 17)

| *Maleic anhydride in polyester* | *Exotherm peak of composition by % (wt.) of styrene* | | | |
|---|---|---|---|---|
| | *20%* | *30%* | *40%* | *50%* |
| *mole %* | *°C* | *°C* | *°C* | *°C* |
| 20 | 93 | 103 | 104 | 105 |
| 40 | 160 | 175 | 176 | 177 |
| 60 | 182 | 204 | 208 | 212 |
| 80 | 184 | 215 | 232 | 238 |
| 100 | 190 | 221 | 245 | 254 |

**Table VII:** Shrinkage and flexural strengths of polyester laminates (reference 14)

| *Type of polyester* | *Polyester/ monomer ratio* | *Shrinkage* | *Flexural strength* |
|---|---|---|---|
| | | *%* | *p.s.i.* |
| X/Styrene | 70/30 | 6.96 | 77,700 |
| X/Styrene | 50/50 | 9.18 | 77,800 |
| X/Styrene | 33/67 | 11.72 | 80,300 |
| Y/Styrene | 65/35 | 8.94 | 68,300 |
| Y/Styrene | 50/50 | 9.68 | 71,100 |
| Y/Styrene | 33/67 | 10.22 | 72,000 |
| Y/MMA | 65/35 | 10.72 | 77,100 |
| Y/MMA | 50/50 | 12.85 | 80,600 |
| Y/MMA | 33/67 | 15.15 | 84,800 |

to factors such as nonuniformity of glass distribution, too high a ratio of resin to glass, too much resin shrinkage (due to exotherm and/or

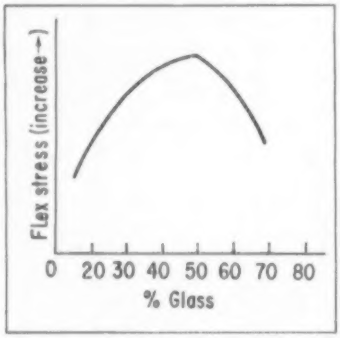



**FIG. 6:** Effect of the glass content on the flexure of polyester moldings.

mold temperature), or insufficient wetting of the glass. Crazing and cracking are also occasionally observed when the molded product is subjected to excessive postcure conditions. Another cause for such defects is the prewetting of the glass fibers with monomers. The monomers, having a much higher polymerization shrinkage than the polymers, will build up greater stresses in the resin-glass interface. Even small amounts of water in the wet lay-up promotes cracking.

Too high a shrinkage often causes the resin to shrink away from the resin-glass interface, thus forming voids which may be visible as "internal fiber blush" or as cracked or crazed areas. Internal fiber blush is often the result of postcure conditions, such as post-baking or exposure to water and humid weather. This effect is more pronounced in molded or laminated products which have not been completely cured, *i.e.*, which contain residual monomers. The monomers are more concentrated in the interfaces, where the heat of reaction is readily dissipated, *e.g.*, along the fibers or along the mold. In the latter case, the mold temperature must be lower than the peak exotherm temperature.

Cracks may also occur along deformations of the cured products. Here, the use of so-called "flexible resins" is advisable. In such cases polyesters containing isophthalic acid or epoxy-modified polyesters may be used. A higher content of glass also tends to alleviate this deficiency, as is seen in Fig. 6, left. Shrinkage plays an important role around the glass fibers as will be discussed later.

**Depression in surface, shrinkage pool, waviness.** These are irregular, slightly depressed areas on the surface of the molding. They are caused by uneven shrinkage before complete hardening is attained (8). This phenomenon is common in contact-pressure lamination in which the pressure is too low to counterbalance uneven shrinkages as mentioned previously. The resin in the vicinity of the glass shrinks less (due to the dissipation of heat) than in the areas where no fibers are present. Therefore, this effect becomes more pronounced the greater the distances between the fibers, especially at and near the surface. This deficiency can be reduced by the use of "closely-knit" surfacing mats. Also higher pressure and longer **(To page 196)**

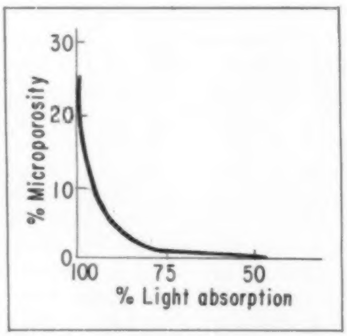



**FIG. 7:** Effect of microporosity on light transmission characteristics of glass-fabric laminates (17).

**Table VIII:** Effects of maleic anhydride and styrene content of cast polyester resin on flexural strength (reference 17)

| *Maleic anhydride in polyester* | *Flexural strength of cast resin containing % (wt.) of styrene* 20% | 30% | 40% | 50% |
|---|---|---|---|---|
| *mole %* | *p.s.i.* | *p.s.i.* | *p.s.i.* | *p.s.i.* |
| 20 | 4,995 | 4,995 | 7,100 | 9,920 |
| 40 | 19,900 | 15,600 | 14,200 | 14,200 |
| 60 | 19,200 | 18,560 | 17,800 | 17,000 |
| 80 | 17,000 | 15,600 | 14,200 | 13,500 |
| 100 | 14,200 | 12,800 | 12,500 | 8,940 |

**Table IX:** Wall thickness versus exotherm peak in polyester moldings

| *Wall thickness* | *Exotherm peak in catalyzed polyester*[a] 0.25% MEKP 0.012% Co | 0.75% MEKP 0.012% Co |
|---|---|---|
| *mm.* | *°C.* | *°C.* |
| 20 | 85 | 145 |
| 50 | 145 | 182 |
| 100 | 189 | 191 |
| 150 | 190 | 195 |

[a] MEKP = methyl ethyl ketone peroxide; Co = cobalt-type catalyst.

**Table X:** Effect of relative humidity of the atmosphere on light transmission of polyester glass-fabric laminates (reference 24)

| *Cure temp.* | *Cure time* | *Light transmission of panels produced at:* 5% RH | 50% RH | 95% RH |
|---|---|---|---|---|
| *°C.* | *hr.* | *%* | *%* | *%* |
| 120 | 2 | 11 | 4 | 4 |
| 105 | 3 | 14 | 7 | 2 |
| 70 | 48 | 50 | 40 | 14 |

# Stability of thermoset plastics at high temperatures

By S. L. Madorsky* and S. Straus*

Polyesters, epoxy, phenolic, and silicone plastics were pyrolyzed in a vacuum at 360, 500, 800, and 1200° C. The volatile products of degradation were collected and fractionated. The lighter fractions were analyzed in the mass spectrometer for product identification and the heavier ones by microcryoscopy for molecular size. Stabilization occurred in all cases in the form of a nonvolatile, more or less carbonized residue. Taking the amount of residue as a measure of thermal stability, the relative stability of these resins is in the following order: silicone >phenolic >polyester >epoxy. The activation energies of thermal degradation are 18, 36, and 51 kcal./mole, respectively, for the phenolic, polyester, and epoxy resins.

During the past few years there has been a growing demand in industry and defense for polymeric substances that would either remain intact or continue to serve even in a more or less degraded state as the protective element of an assembly under conditions in which temperatures far above the ordinary are encountered. In many cases, highly cross-linked organic polymers have been found to meet such requirements. When such polymers are heated to temperatures above about 500° C., they give off gaseous products, absorb heat in the degradation process, and leave behind a carbonaceous residue. All of these phenomena are helpful in reducing the effect of heat on parts that it is desired to protect.

### *Materials investigated*

The following plastics were studied in an investigation of the behavior of some thermoset resins during pyrolysis in a vacuum:

**Polyester.** The uncured material, Vibrin 136A from Naugatuck Chemical Co., was described as consisting of approximately equal parts by weight of a modified maleic anhydride unsaturated alkyd and monomeric triallyl cyanurate. Hydroquinone (less than 100 p.p.m.) was used as inhibitor. The material was cured in the presence of 0.2% of *tert*-butyl perbenzoate by heating for 15 min. at 50° C. and then degassing in a vacuum (about 5 mm. Hg) for 10 minutes. It was next heated for 2 hr. at 121° C. The temperature was then raised over a period of 1 hr. to 260° C. and kept constant for 3 hours. The product was a transparent hard glass of light amber color. Elemental analysis showed C 54.8%, H 5.3%, N 7.5%, and O (by difference) 32.4 percent.

**Epoxy.** The uncured material, Epon 1310 from Shell Chemical Corp., was described as a condensation product of epichlorohydrin and polyphenol. The polyphenol is a novolac type of resin having between three and four phenolic hydroxyl groups per molecule. The molecular weight of Epon 1310 varied from about 725 to 775 and had an equivalent weight per epoxide group of about 200. It contained a small amount of chlorine due to the epichlorohydrin used in its manufacture. In curing this resin, 50 parts of powdered

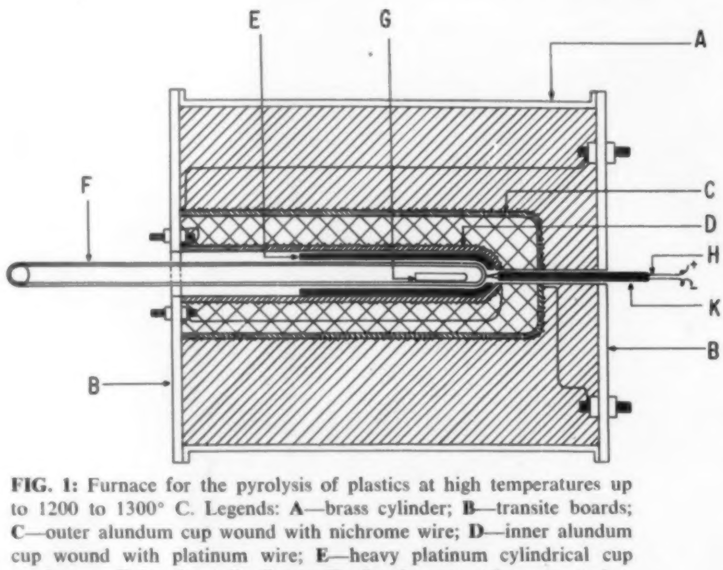



FIG. 1: Furnace for the pyrolysis of plastics at high temperatures up to 1200 to 1300° C. Legends: **A**—brass cylinder; **B**—transite boards; **C**—outer alundum cup wound with nichrome wire; **D**—inner alundum cup wound with platinum wire; **E**—heavy platinum cylindrical cup serving as efficient heat distributor; **F**—fused quartz tube connected to a glass vacuum apparatus; **G**—platinum cylindrical cup (the sample is placed in this cup close to its bottom); **H**—platinum-platinum rhodium thermocouple which is held in a fine alundum tube, **K**, and touches the bottom of the quartz tube, **F**.

* National Bureau of Standards, Washington, D. C.
This research was supported by the U. S. Air Force under Project (33-616)58-8, monitored by Materials Central Directorate of Advanced Systems Technology, Wright Air Development Division.

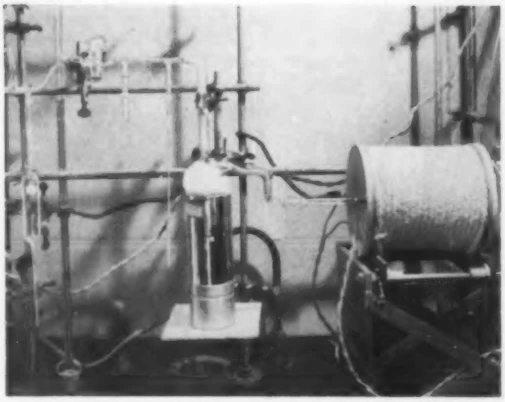


FIG. 2: Photograph of assembled apparatus.

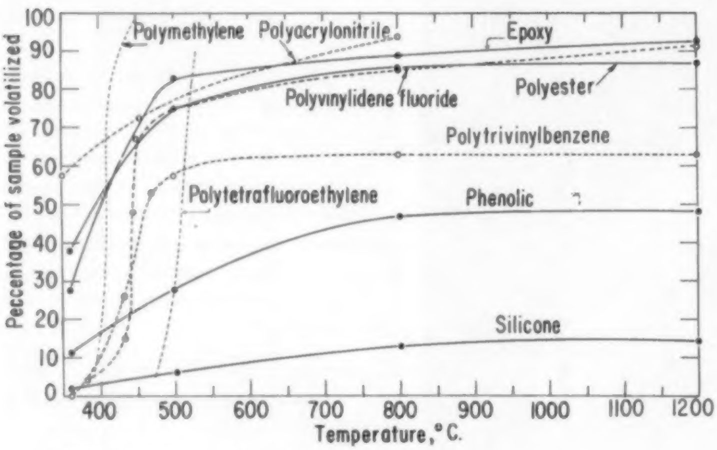



FIG. 3: Relative thermal stability of plastics.

Epon 1310 was added slowly with constant stirring to a solution of 0.5 part of $BF_3$-monoethylamine complex in 40 parts of acetone. The mixture was spread on a glass plate, dried at 66° C. until hard, and exposed overnight at room temperature and humidity. It was then cured for 1 hr. at 157° C. and finally postcured for 3 hr. at 205° C. The final product was a transparent hard glass of amber color. The exact chemical nature of the resin is not known. However, it is known to consist chiefly of carbon, hydrogen, and oxygen. Elemental analysis showed it to contain C 69.7%, H 5.9%, and O + Cl (by difference) 24.4 percent.

**Phenolic.** The uncured resin, CT-91-LD from Cincinnati Testing and Research Laboratories, was described as a phenol-formaldehyde resin catalyzed by the addition of an alkali. It was cured by heating 15 min. at 94° C., 15 min. at 107° C., and 30 min. at 127° C. This was followed by a postcure which consisted in placing the material in an oven at 121° C., raising the temperature of the oven over a period of 3 hr. to 260° C., and then maintaining this temperature for 2 hours. The product was a dark brown hard glass. Its actual chemical composition is not known. However, elemental analysis showed a composition of C 77.0%, H 6.1%, and O (by difference) 16.9

**Table I:** Pyrolysis of thermoset plastics

| *Plastic* | *Pyrolysis temp.* | *Time at temp.* | *Volatilization* | *Fractions, based on volatilization* $V_{25}+V_{-196}$ | $V_{pyr}$ | *Appearance of residue*[a] |
|---|---|---|---|---|---|---|
| | °C. | min. | % | % | % | |
| Polyester | 360 | 60 | 28 | 66.5 | 33.5 | A,B,D |
| | 500 | 30 | 83 | 47.4 | 52.6 | A,C,F |
| | 800 | 5 | 89 | 55.7 | 44.3 | A,F,K |
| | 1200 | 5 | 93 | 61.8 | 38.2 | A,F,K |
| Epoxy | 360 | 60 | 38 | 36.4 | 63.6 | A,B,D |
| | 500 | 30 | 75 | 18.0 | 82.0 | A,C,F |
| | 800 | 5 | 86 | 26.9 | 73.1 | A,F,K |
| | 1200 | 5 | 87 | 49.1 | 50.9 | A,F,K |
| Phenolic | 360 | 60 | 11 | 25.0 | 75.0 | G |
| | 500 | 30 | 28 | 50.1 | 49.9 | A,B,D,F |
| | 800 | 5 | 44 | 40.4 | 59.6 | A,B,F |
| | 1200 | 5 | 48 | 62.4 | 37.6 | A,B,F |
| Silicone | 360 | 60 | 2 | — | — | G |
| | 500 | 30 | 6 | 91.3 | 8.7 | B,D,E,H |
| | 800 | 5 | 13 | 86.7 | 13.3 | A,B,D |
| | 1200 | 5 | 17 | — | — | A,B |

[a] Key to letters: A—turned black; B—retained shape; C—retained shape, but became slightly buckled; D—retained gloss; E—retained some transparency; F—became opaque; G—no apparent change; H—smoky in color; K—shrunk.

**Table II:** Analysis of volatile products from pyrolysis of polyester

| Component[a] | Amount in volatile products[b] At 360°C. | At 500°C. | At 800°C. | At 1200°C. |
|---|---|---|---|---|
| | % | % | % | % |
| Hydrogen | — | — | 0.7 | 1.3 |
| Carbon monoxide | 3.3 | 2.9 | 9.2 | 7.2 |
| Carbon dioxide | 62.4 | 41.4 | 29.3 | 24.9 |
| Methane | — | 0.7 | 1.8 | 3.4 |
| Ethane | — | 0.6 | — | — |
| Ethylene | — | 0.6 | 6.5 | 14.8 |
| Allene | — | — | — | 1.0 |
| Propylene | 0.8 | — | 2.5 | 1.6 |
| Butenes | — | — | 1.5 | — |
| Butadienes | — | — | — | 1.4 |
| Cyclopentadienes | — | — | — | 1.3 |
| Pentanes | — | 0.7 | — | — |
| Pentenes | — | 0.5 | — | — |
| Pentadienes | — | — | 2.6 | — |
| Benzene | — | — | 1.3 | 4.7 |
| Others (not shown) | — | 0 | 0.3 | 0.2 |
| $V_{pyr}$ | 33.5 | 52.6 | 44.3 | 38.2 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |
| Volatilized part of sample, % | 28 | 83 | 89 | 93 |

[a] Components in amounts of less than 0.5% are not shown. [b] Percentages are based on weight of total volatilized part.

percent. This composition corresponds approximately to a 1:1 ratio of phenol to formaldehyde, which has a composition of C 78.4%, H 6.5%, and O 15.1 percent.

**Silicone.** The uncured resin, DC 2106, supplied by Dow-Corning Corp. in the form of a 60% solution in toluene, was described as containing methyl and phenyl groups on the main chain. The curing agent supplied with the resin was designated as XY-15, but its chemical nature was not disclosed. However, it was stated that this catalyst is fugitive and would decompose at the temperature employed in the curing process. The curing regime consisted in adding 0.21% of XY-15, calculated on the basis of the resin, to the resin solution. The solution was spread on a glass plate and dried overnight at room temperature or for 2 to 3 hr. at 66° C. It was then precured for 15 min. at 107° C., cured for 30 min. at 127° C., and postcured for 3 hr. at 91° C. The temperature was then raised over a 2-hr. period to 260° C. and kept at this point for 4 hours. The final product was a transparent hard glass of a slight shade of pink. Analysis showed C 41%, H 4%, Si 29.5%, and O (by difference) 25.5 percent.

The thermal degradation of the thermoset plastics was carried out in a vacuum. This eliminated the oxidation of the products by atmospheric oxygen, thus limiting the reactions to purely thermal effects. An inert atmosphere was excluded in order to facilitate the escape of the volatile products from the hot zone where they would otherwise undergo secondary reactions. Collection, fractionation, and analysis of the volatile products are simpler and easier under these conditions than when these products are mixed with extraneous gases.

The results of the investigation will be presented in two parts: 1) pyrolysis of the polymer with subsequent analysis of the degradation products and 2) determination of rates of degradation and activation energies of the reactions involved in the degradation.

### Pyrolysis

The effects of pyrolysis on the thermoset plastics were studied at 360, 500, 800, and 1200° C. A 10- to 50-mg. sample was weighed into a small cylindrical platinum container, which was placed in a finger-like quartz tube attached to a glass vacuum apparatus by a ground joint. The system was evacuated to about $10^{-4}$ mm. Hg, and an electric furnace, which had been preheated to the required temperature, was moved into position to heat the sample. The temperature was measured by means of a Pt Pt-10% Rh thermo- **(To page 143)**

**Table III:** Analysis of volatile products from pyrolysis of epoxy resin

| Component[a] | Amount in volatile products[b] At 360°C. | At 500°C. | At 800°C. | At 1200°C. |
|---|---|---|---|---|
| | % | % | % | % |
| Hydrogen | — | — | 0.8 | 2.1 |
| Carbon monoxide | 4.7 | 3.1 | 11.2 | 25.9 |
| Carbon dioxide | 16.2 | 6.0 | 3.7 | 1.8 |
| Methane | 1.0 | 0.8 | 1.6 | 4.3 |
| Acetylene | 0.3 | — | — | 2.5 |
| Ethylene | — | — | 3.0 | 3.0 |
| Acetone | 0.9 | 2.2 | — | — |
| Propane | — | 1.1 | — | — |
| Propylene | 6.5 | 2.3 | 2.2 | — |
| Ethane | — | — | 1.6 | — |
| Cyclopentadienes | — | — | — | 0.6 |
| Pentanes | — | 0.5 | — | — |
| Benzene | — | 1.3 | 2.8 | 8.1 |
| Methyl chloride | 5.1 | — | — | — |
| Ethyl chloride | 1.7 | — | — | — |
| Others (not shown) | — | 0.7 | 0 | 0.8 |
| $V_{pyr}$ | 63.6 | 82.0 | 73.1 | 50.9 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |
| Volatilized part of sample, % | 38 | 75 | 86 | 87 |

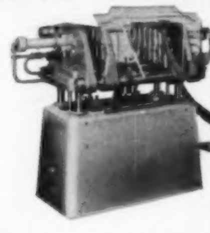
[a] Components in amounts of less than 0.5% are not shown. [b] Percentages are based on weight of total volatilized part.

# The Rainville Company has the most complete selection of plastic equipment!

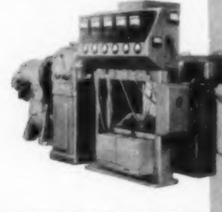

Management and Personnel at a recent sales meeting

Rainville Research and Development Laboratory

## BLOW MOLDING E



1. ½ Gallon Blow-O-Matic Rising Mold Type Machine



5. Rainville Rotary Blow Molding Machine—6 Station—100
with TRS 80—3¼" Luigi Bandera Extruder with double zo

## EXTRUSION EQUIF

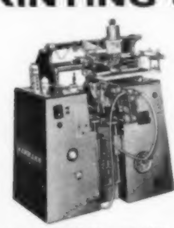
9. TR 30 (1⅛") Bandera Extruder

10. TR 120

14. Vern Emery Saw—Model 4 cuts up to 4" pipe

15. Vern Er
up to 9" pi

## PRINTING & MARK



19. Kammann K 10 Manual Silk Screening Machine for round objects such as blown bottles

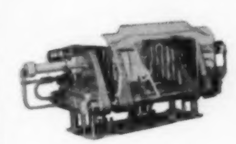
20. Kamma
Bottle Silk

## FOREMOST SCRA

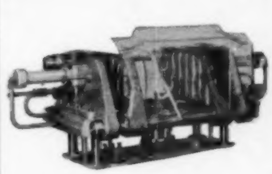
24. 3C-2 Hi-Shear Grinder—
10" x 12" Throat; 3 or 5 hp motor

25. HD-1 
8½" x 10

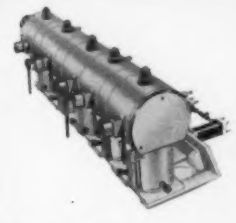
## QUIPMENT



2. 2½ Gallon Blow-O-Matic Table

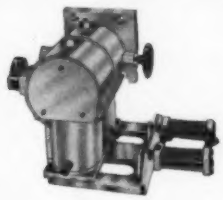


3. 5 Gallon Blow-O-Matic Table

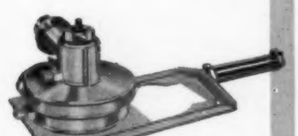


4. 1½" Parison Head—5 Station

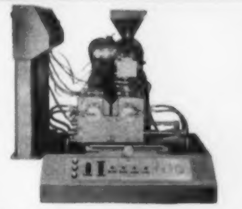
00 per hour dry cycles, one extrusion head.



6. 2" Double Head—Adjustable Parison Wall

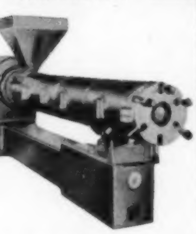


7. 15" Single Crosshead



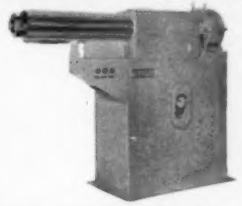
8. S.C.A.E. (made in Italy) One Size —One Quart—1200 Dry Cycles— Air Operated

## PMENT

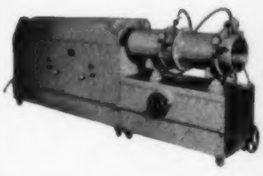


0 (4¾") Bandera Extruder

11. Rainville 2½" Extruder—20 to 1 L/D Ratio—42" Centerline— Standard Arrangement

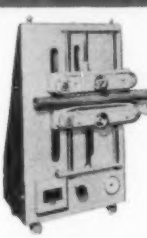


12. Rainville 2½" Extruder—20 to 1 L/D Ratio—Base Arrangement for Blow Molding



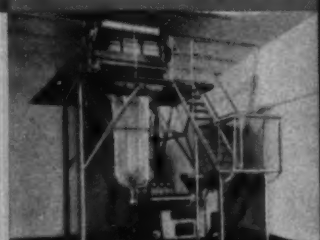
13. Bandera Vacuum Pipe Sizer

Emery Saw—Model 9 cuts pipe



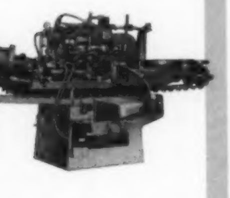
16. Speedex Model 0/3 Puller

17. Speedex Model 0/5 Tractor-Type Haul Off (up to 5" capacity)

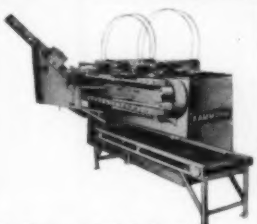


18. Bandera Complete Film Installation

## KING EQUIPMENT

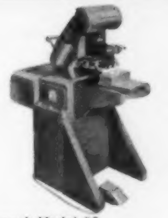


nann K 5 B Fully Automatic k Screening Machine



21. Kammann K 11 Automatic Sidewall Printer

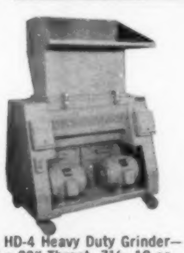
22. Rainmark Model 25 High Capacity Rotary Hot Stamping Machine



23. Rainmark Model 30 Reciprocating Table Hot Stamping Machine

## AP GRINDERS

Heavy Duty Grinder— 0" Throat; 3 or 5 hp motor



26. HD-4 Heavy Duty Grinder— 10" x 28" Throat; 7½, 10 or 15 hp motor

27. HD-2 Grinder Equipped for Pipe Grinding

28. Heavy Duty Model 6B Lump Cutter

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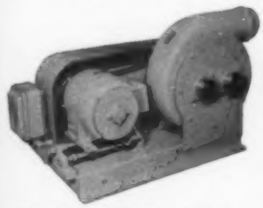
John Stracey
Stanley Currans

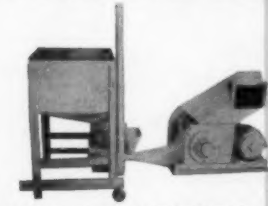
**The Rainville Company, Inc.**

*839 Stewart Ave., Garden City, L. I., New York*

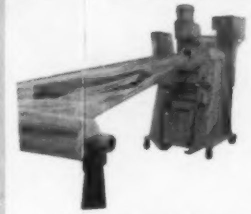
## FOREMOST AUTOMATIC SCRAP HANDLIN



**28.** Cutter Blower for automatic removal of sheet edge trim



**30.** Under-the-Press Grinder-Blender-Loader. Scrap inlet height as low as 16" from ground



**31.** 3C-2 Roll-Feed Grinder for grinding scrap in roll form

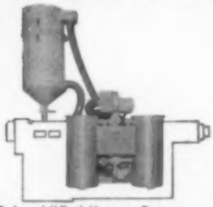
## LOADING AND MIXING

**35.** Foremost 1" Automatic Hopper Loader including Level Switches, Drum Clamp, Solenoid Valve, etc.

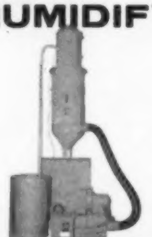
**36.** Rainco Drum Tumbler with Floor-Level Loading

**37.** Rainco Flake Loader

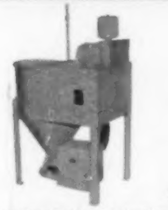
## DRYING AND DEHUMIDIFYING



**41.** Dehumidified Hopper Dryers. A complete line of efficient dryers from 50 to 1000 lbs. per hour

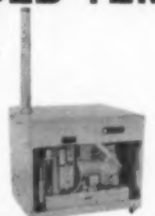


**42.** Una—Dyn Hopper Dryer complete with efficient air distribution hopper and dust-free Rainco Vacuum Loader



**43.** Una Dyn Model AO-2—Floor Loading Combination Dryer-Hoppe Loader

## MOLD TEMPERATURE CONTROL

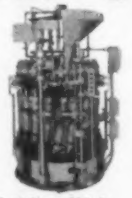


**47.** Rainkool Refrigerating and Recirculating Units—Air Cooled and Water Cooled

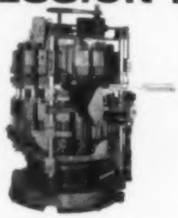
**48.** Autotherm Model 801 Single Zone Mold Temperature Control Unit—50 degrees F to 230 degrees F

**49.** Autotherm Model 802 Dual Z Mold Temperature Control Unit—50 degrees F to 230 degrees F

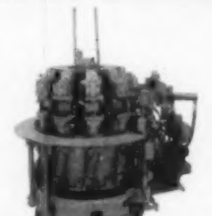
## ROTARY COMPRESSION MOLDING



**53.** Cropp 20 station—3½ to 10 tons per station. Fully automatic continuous compression molding with powder or preforms.



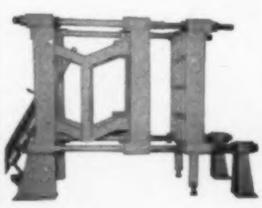
**54.** Cropp Hydraulic 20 station—8 tons per station



**55.** Cropp Rotary Transfer Press

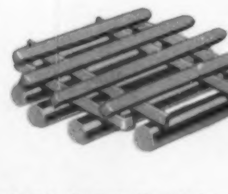
## EXPANDABLE POLYSTYRENE

**59.** Slocomb Expandable Polystyrene Steam Expander—Model 2 shown. Available in 3 sizes



**60.** Rainco Expandable Styrene Molder

## MISCELLAN



**61.** Rainville Grate Magnets for ferrous metal contamination

## NG SYSTEMS

32. Plant installation of complete automatic Grinder-Blender-Loader for film

**33.** Adapter Unit and Impeller Loader to convert any standard grinder to an automatic Grinder-Blender-Loader

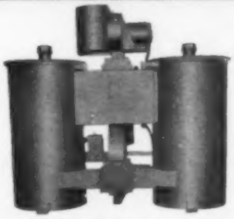
**34.** Model 3XX Grinder with variable speed feed roll for light gauge sheet

**38.** Rainco Standard Vacuum Loader —1200 pounds per hour capacity

**39.** Rainco High Capacity Vacuum Loader—1800 pounds per hour capacity

**40.** Rainco Loader with Dust Tight Mounting

per

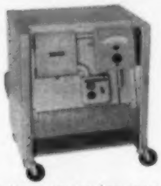


**44.** Model AM-15 Molecular Sieve Dehumidifier

**45.** Foremost 20—Tray Oven

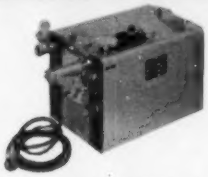
**46.** Foremost 40—Tray Oven

Zone
—



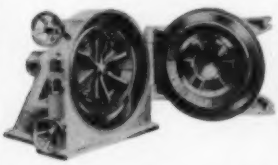
**50.** Autotherm Model 805 Single Zone Atmospheric Pressure Unit—4500 Watt Control Unit—50 degrees F to 210 degrees F

**51.** Autotherm Model 807 Dual Zone Hot Oil Mold Temperature Control Unit—100 degrees F to 500 degrees F

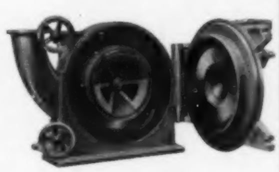


**52.** Autotherm Model 810 Cooling Only Unit for Vacuum Forming or Extrusion Screw Cooling for Use on Water Only—50 degrees F to 210 degrees F

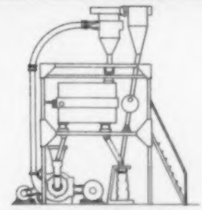
## FINE GRINDING EQUIPMENT



**56.** Pallmann PP 6 for "powdered" thermoplastics down to 100 mesh without refrigerant

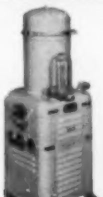


**57.** Pallmann RF 8



**58.** Pallmann complete plant installation with automatic screening

## NEOUS



**62.** Mayhew Oil Reconditioner—Model MT-1


**63.** Model 30 Doyle Vacuum Cleaner

**64.** Rainville Mold Release

| | |
|---|---|
| 1 to 4 cases | $12.00 per case |
| 5 to 9 cases | 11.50 per case |
| 10 to 24 cases | 11.00 per case |
| 25 to 49 cases | 10.50 per case |
| 50 or over | 10.00 per case |

couple. Duration of each experiment at 360 and 500° C. was 5 min. of preheating and 30 min. at the operating temperature. At 800 and 1200° C., the preliminary period was 2 min., and the heating period at the operating temperature was 5 minutes. The apparatus and the experimental procedure were described in detail in a previous publication (1)[1]. The electric furnace used for the experiments at 800° C. and below was also described in the same reference.

For the experiments at 1200° C. a new electric furnace was constructed (Fig. 1, p. 134). The temperature of pyrolysis in the new furnace was calibrated by placing a Pt/PtRh thermocouple inside the platinum cylindrical cup *G* in a position where the sample would normally be placed, and then checking its temperature against the temperature of a similar outside thermocouple *H* while the apparatus was kept evacuated. Although the temperature of the furnace could be raised to 1500° C., pyrolysis experiments were limited to 1200° C. because of the tendency of the fused quartz tube *F* to crystallize above this temperature. A photograph of the assembled apparatus is shown in Fig. 2, p. 136.

The volatile products noncondensable at the temperature of liquid nitrogen were collected as a gaseous fraction and designated as $V_{-196}$. A sample of it was analyzed in a mass spectrometer, and the total weight of this fraction was then calculated from its volume, pressure, and analysis. Another fraction, $V_{25}$, volatile at room temperature, was collected at liquid-nitrogen temperature in a 3-mm. O.D. weighed glass tube attached to the apparatus by means of a ground joint. The tube was then sealed off by fusion, weighed, and the contents analyzed in the mass spectrometer. A heavy fraction, $V_{pyr}$, volatile at the temperature of pyrolysis but not at room temperature, deposited in the finger-like extension of the apparatus, just beyond the hot zone. This fraction was collected by dissolving in a suitable solvent. The solvent was then evaporated and the residue weighed, and tested for average molecular weight by a microcryoscopic method. The residue

[1] Figures in parentheses indicate literature references at the end of this paper, p. 210.

**Table IV:** Analysis of volatile products of pyrolysis of phenolic resin

| *Component*[a] | *Amount in volatile products*[b] *At 360°C.* | *At 500°C.* | *At 800°C.* | *At 1200°C.* |
|---|---|---|---|---|
| | % | % | % | % |
| Hydrogen | — | — | 3.6 | 5.6 |
| Carbon monoxide | — | 3.5 | 16.2 | 24.6 |
| Carbon dioxide | 0.5 | 5.5 | 2.7 | 2.1 |
| Methane | — | 4.3 | 12.6 | 9.0 |
| Acetylene | — | — | — | 2.8 |
| Ethylene | — | — | 1.5 | 2.4 |
| Acetone | 6.7 | 17.6 | 1.0 | — |
| Propylene | 4.0 | — | 1.0 | 3.4 |
| Propanols | 10.9 | 11.1 | — | — |
| Butanols | 2.9 | — | — | — |
| Cyclopentadienes | — | — | — | 3.1 |
| Benzene | — | 2.5 | 0.6 | 2.8 |
| Toluene | — | 4.7 | 0.5 | — |
| Dimethylbenzene | — | 0.9 | — | — |
| Others (not shown) | — | 0 | 0.7 | 6.6 |
| $V_{pyr}$ | 75.0 | 49.9 | 59.6 | 37.6 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |
| Volatilized part of sample, % | 11 | 28 | 44 | 48 |

[a] Components in amounts of less than 0.5% are not shown. [b] Percentages are based on weight of total volatilized part.

**Table V:** Analysis of volatile products from pyrolysis of silicone resin

| *Component* | *Amount in volatile products*[a] *At 500°C.* | *At 800°C.* | *At 1200°C.* |
|---|---|---|---|
| | % | % | % |
| Hydrogen | — | 18.4 | 17.9 |
| Carbon dioxide | 0.6 | 0.6 | 5.1 |
| Methane | 6.3 | 14.7 | 9.2 |
| Ethylene | — | 1.6 | 0.4 |
| Acetone | 2.3 | — | — |
| Propylene | 6.1 | — | — |
| Butenes | 1.2 | — | — |
| Butadienes | 1.2 | — | — |
| Hexadienes | 1.2 | — | — |
| Benzene | 72.4 | 51.4 | 17.5 |
| $V_{pyr}$ | 8.7 | 13.3 | 49.9 |
| Total | 100.0 | 100.0 | 100.0 |
| Volatilized part of sample, % | 6 | 13 | 17 |

[a] Percentages are based on weight of total volatilized part.

**Table VI:** Analysis of residues from pyrolysis of phenolic resin

| *Pyrolysis temp.* | *Amount of residue* | *Analysis of residue* *C* | *H* | *O* |
|---|---|---|---|---|
| °C. | % | % | % | % |
| — | — | 77.0[a] | 6.1[a] | 16.9[a] |
| 500 | 69.7 | 87.6 | 4.6 | 7.8 |
| 800 | 54.4 | 96.0 | 1.7 | 2.3 |
| 1200 | 51.6 | 99.2 | 0.3 | 0.5 |

[a] Analysis of original material.

from the pyrolyzed polymer was weighed and analyzed by a microchemical method.

Table I, p. 136, shows the pertinent experimental conditions and results of pyrolysis. The percentage volatilization is plotted in Fig. 3, p. 136, as a function of temperature of pyrolysis for the four plastics. For purposes of comparison, the graph shows curves for polytrivinylbenzene, polyvinylidene fluoride, and polyacrylonitrile, which have been studied previously (1, 2), and also for polymethylene (3) and polytetrafluoroethylene (4).

Analysis of the volatile products was made in a mass spectrometer. Some oxygenated compounds, which appeared in small amounts in some of the analyses, could not be identified because mass spectrometer patterns are not available for them. In the case of the polyester, nitrogen is present in the plastic to the extent of 7.5 percent. This element could be masked somewhat by carbon monoxide since both have the same molecular weight, or it could be present in the $V_{pyr}$ or in the residue.

Results of analysis of the volatile products from the polyester, epoxy, phenolic, and silicone resins are shown in Tables II, III, IV, and V, pp. 138, 143, respectively. In the case of the polyester, epoxy, and phenolic resins, $CH_4$ and $H_2$ appear among the volatile products, in addition to $CO_2$ and CO. In the pyrolysis of the silicone resin, $H_2$, $CH_4$, and $C_2H_6$ are the most abundant.

The average molecular weight for the fraction $V_{pyr}$ was obtained for the polyester, epoxy, and phenolic resins pyrolyzed at 800° C. by microcryoscopy with camphor as the solvent. The values found were 220, 350, and 340 for the three resins, respectively. A similar determination for the silicone resin could not be made because of lack of a suitable solvent. Chemical analysis of residue was made for the phenolic resin. For results, see Table VI, p. 143.

### Degradation rates

Rates of thermal degradation of the resins were measured on 5- to 10-mg. samples by the loss-of-

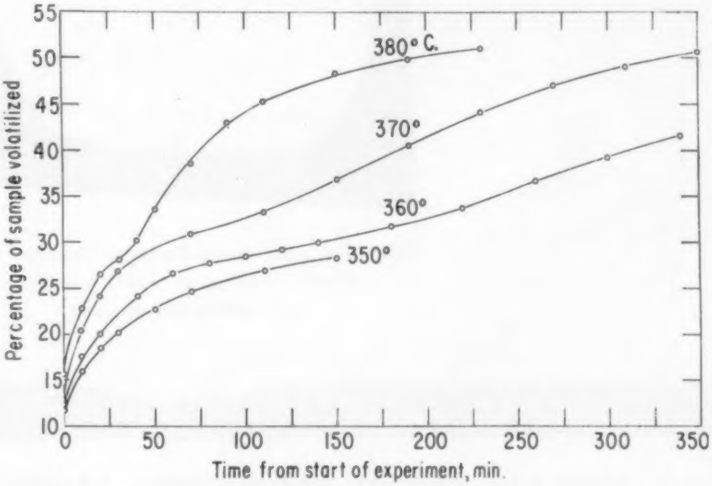
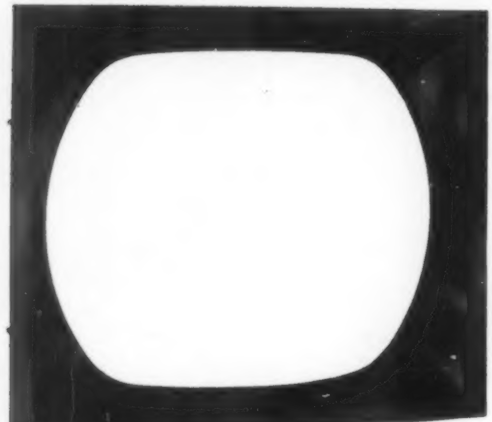



**FIG. 4:** Thermal degradation of polyester resin.

**Table VII:** Rates of thermal degradation of thermoset plastics

| Plastic | Pyrolysis temp. | Heating time | Loss of weight: Amount | Loss of weight: Rate | Activation energy |
|---|---|---|---|---|---|
| | °C. | min. | % | %/min. | kcal./mole |
| Polyester | 350 | 150 | 28.4 | 0.210 at 18% loss | |
| | 360 | 340 | 41.7 | 0.310 at 18% loss | 36 |
| | 370 | 350 | 50.7 | 0.520 at 18% loss | |
| | 350 | 150 | 28.4 | 0.167 at 20% loss | |
| | 360 | 340 | 41.7 | 0.249 at 20% loss | 37 |
| | 370 | 350 | 50.7 | 0.455 at 20% loss | |
| | 380 | 230 | 51.0 | 0.650 at 20% loss | |
| | 350 | 150 | 28.4 | 0.125 at 22% loss | |
| | 360 | 340 | 41.7 | 0.204 at 22% loss | 45 |
| | 370 | 350 | 50.7 | 0.385 at 22% loss | |
| | 350 | 150 | 28.4 | 0.085 at 24% loss | |
| | 360 | 340 | 41.7 | 0.167 at 24% loss | 52 |
| | 370 | 350 | 50.7 | 0.318 at 24% loss | |
| | 350 | 150 | 28.4 | 0.057 at 26% loss | |
| | 360 | 340 | 41.7 | 0.102 at 26% loss | 58 |
| | 370 | 350 | 50.7 | 0.244 at 26% loss | |
| Epoxy | 340 | 250 | 39 | 0.311 at 0 time[a] | |
| | 350 | 260 | 47 | 0.575 at 0 time[a] | 51 |
| | 360 | 220 | 51 | 1.160 at 0 time[a] | |
| Phenolic | 355 | 110 | 9.6 | 0.098 at 7 % loss | |
| | 380 | 100 | 10.1 | 0.154 at 7 % loss | 18 |
| | 331.5 | 1200 | 10.4 | 0.033 at 0 time[a] | |

[a] Values at 0 time were obtained by extrapolation of curves (initial rates).



Television escutcheon frame in lustrous black plastic, molded to resist warping and retain dimensions.

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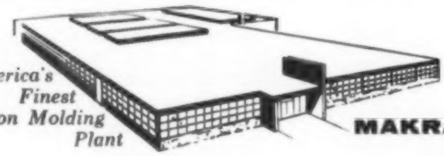

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weight method using two types of apparatus. The first type (5), used for measuring faster rates at higher temperatures, consisted of a very sensitive tungsten spring balance enclosed in a glass vacuum system. Readings of the loss of weight were made at intervals during the experiment by observing, through a cathetometer, the position of a crosswire attached to an extension from the spring, with respect to a line on a window in the apparatus in front of the crosswire. The temperature was read at intervals by means of a potentiometer. The second apparatus (6), used for slower rates at lower temperatures, consisted of an Elmic microbalance enclosed in a polymethyl methacrylate–Pyrex vacuum apparatus. The loss of weight of the sample and the temperature of operation were recorded automatically. This permitted running experiments over long periods of time without attention. The vacuum in both types of apparatus was maintained at about $10^{-5}$ mm. Hg, and the temperature, as indicated by chromel-constantan thermocouples was controlled to within ±0.1° C. by means of an electronic thermostat (5).

**Polyester.** The percentages of volatilization of the polyester measured by means of the spring balance are shown plotted as a function of time in Fig. 4. The shapes of these curves are irregular, and different from those found in our earlier studies (1, 3, 5, 6, 7), in which the rates approximately **(To page 207)**

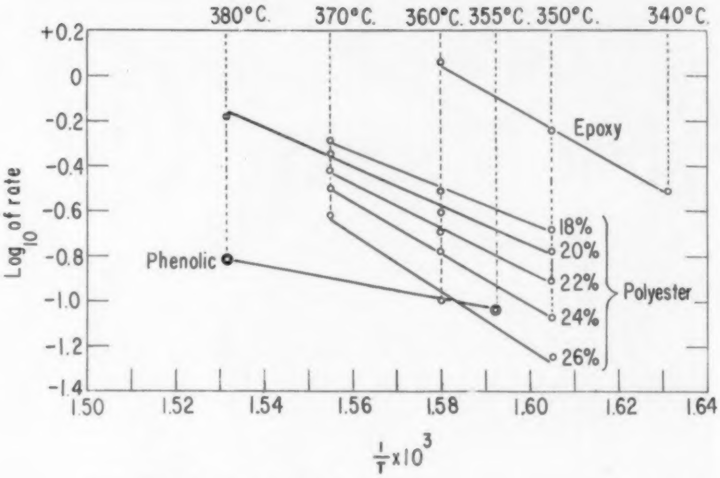


**FIG. 5:** Activation energies of thermal degradation of thermoset plastics.

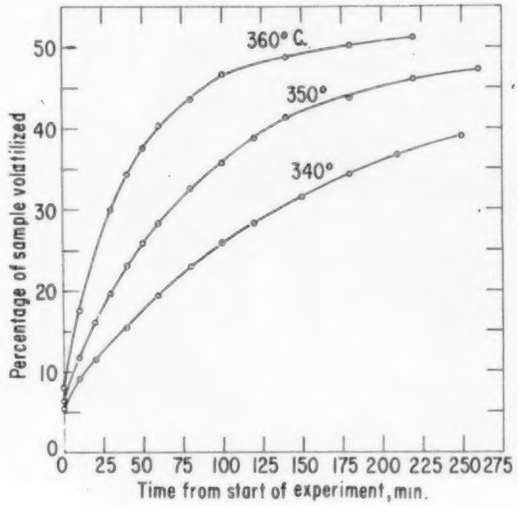


**FIG. 6:** Thermal degradation of epoxy resin.

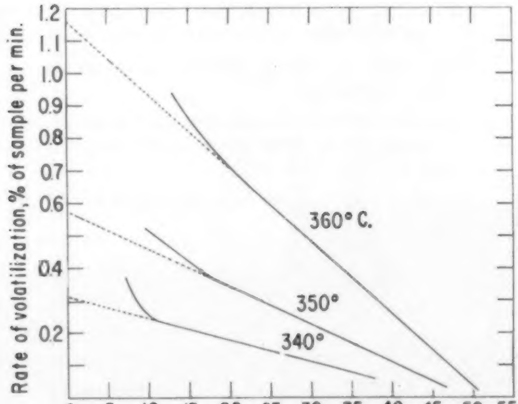


**FIG. 7:** Rate of volatilization of epoxy resin.

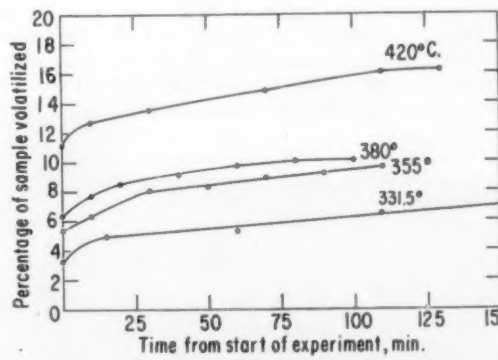


**FIG. 8:** Thermal degradation of phenolic resin.

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The Egan Extruder illustrated at right is a 4½" model with 24:1 L/D ratio.

Patented

The heart of the improved Willert System is its AIR COOLED CONDENSERS, which are constructed of high pressure finned tubing and are located within the cylinder covers of the extruder. Individual zones along the cylinder are jacketed and connected to these condensers forming a closed system. Blowers are mounted in the base (see photo above) and, when in operation, remove the latent heat of vaporization. Therefore, excessive frictional heat is removed *automatically*, without thermal shock, providing uniform thermal regulation *regardless of viscosities or melt temperatures.*

The result is closer tolerance extrusions at greatly increased outputs.

Egan Extruders with the new Air Cooled Willert System are available in sizes from 2" through 12", with L/D ratios of 20:1, 24:1, 32:1.

Detailed information is available upon request.

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# NEW DEVELOPMENTS

Many minds at work on new ways to use plastics, new designs, and new product concepts offer ideas you can use.

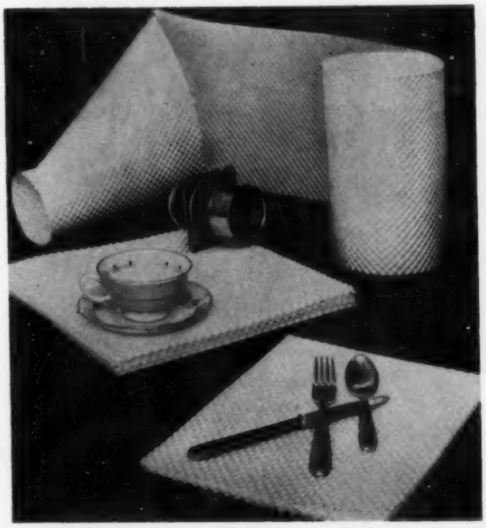
### Sheet foam for cushioning

Extruded polystyrene foam, available in rolls or sheets up to 36 in. wide and in 10-, 20-, and 30-mil thicknesses, is now being offered to packagers as a cushioning material for which a number of important advantages are claimed.

The new foam material, stated to be priced competitively with paper, is reported to be very light in weight (5 lb./1000 sq. ft. in 10-mil thickness), to have extreme resiliency, and to provide desirable thermal insulation. Thus, it not only protects the products but also will considerably reduce over-all weight and shipping costs.

This new polystyrene foam is called Xan-Pak by the manufacturer, Dyna-Foam Corp., Ellenville, N. Y., a subsidiary of Sun Chemical Corp. The material is also said to be non-abrasive, chemically inert, non-dusting, and lint-free. It thus holds promise for packaging highly polished products such as optical lenses, cutlery, furniture, fine china, and jewelry. Because Xan-Pak is, in addition, a thermal insulator (K factor is 0.27) and is also greaseproof and waterproof, additional fields of potential packaging uses include frozen foods, ice cream, candy, butter, and a wide range of other products affected by temperature changes.

Price of Xan-Pak per 1000 sq. ft. in rolls is as follows: 10-mil, $8; 20-mil, $15; 30-mil, $21. An additional charge is made for sheeting the material.



**EXTRUDED PE FOAM** is insulating, shock-absorbing. Designed for packaging of fragile items such as china and lenses and of highly polished silver, it is made in three thicknesses.

## Hospital supplies produced from polypropylene

### Thermoformed sitz bath

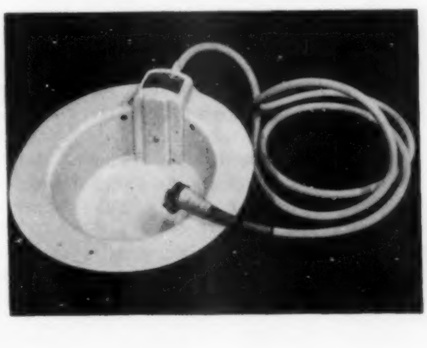
Light weight and autoclavability were the primary reasons for specifying polypropylene for a line of sitz baths for hospitals and homes. The product also represents one of the first applications of vacuum-formed polypropylene sheet. The units are patented and manufactured by Harlan M. Buck Inc., Rye, N. Y.

According to D. M. Saulson, vice-president of Buck, various other materials had been tried, but proved unsuitable. Acrylonitrile-butadiene-styrene (ABS) was eliminated because it did not meet the high-heat requirements posed by hospital needs. High-density polyethylene was reportedly not stable at 250° F. And tests on polycarbonates indicated the material was too hydroscopic for vacuum forming.

And the low specific gravity of polypropylene, the light weight (2 lb. for the entire unit), and the rugged construction needed to make the unit portable yet rugged were other factors in favor of polypropylene's choice.

The sitz baths are vacuum formed for Buck by Speck Plastics Inc., Nazareth, Pa., using sheet material extruded by Campco Div., Chicago Molded Products Inc., Chicago, from AviSun resins. The units are produced on an Aero-Flow machine using sandwich heaters and a single-cavity cast aluminum mold.

Several thousand sitz baths have been produced. Their success has led to plans to produce similar hospital equipment by the same method.



### Blown urinal

Non-breakable, light in weight, and capable of being steam sterilized at temperatures up to 300° F., a blow-molded polypropylene male urinal introduced by American Hospital Supply Corp., Evanston, Ill., offers many advantages over glass and metal units.

Although more costly than glass urinals, which present a constant breakage problem, the plastic unit is less than half the cost of stainless steel. Cubic centimeter and ounce graduations molded directly into the side of the urinal permit volume readings directly through the translucent white wall of the vessel, eliminating the need to transfer contents into a glass container when a check must be made on patient's fluid output.

The unit, developed by AHSC in conjunction with Berman Bros., Chicago, is blow molded of Hercules Pro-fax material. To give it a finished edge, the open end is flame-treated after the tip has been trimmed; this operation softens and rounds the lip of the vessel.

**(More on next page)**

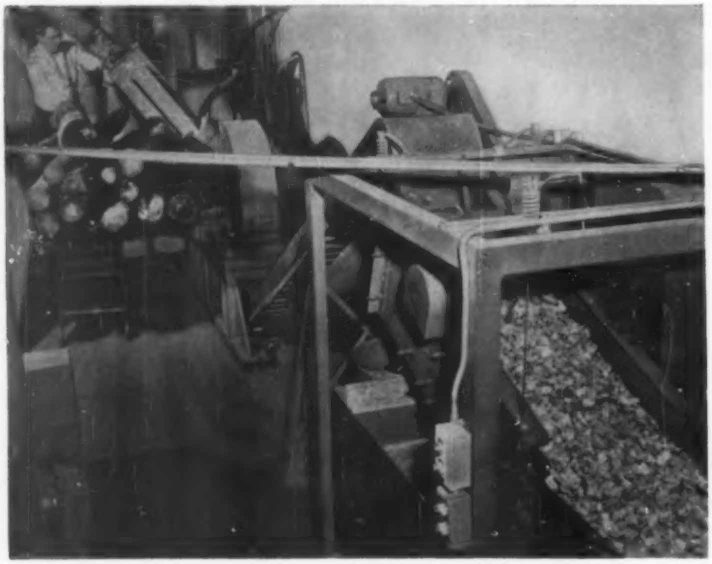
## Low-cost composite material for contoured "wooden" shapes

Wood chips, chopped fibrous glass, and polyester resin, molded at 300 to 500 p.s.i. in relatively inexpensive molds, hold promise of providing a lower-cost replacement for solid wood in a number of applications calling for compound curves as well as intricate contours.

The material compositions and the process by which it is molded were developed by Gisholt Machine Co., Madison, Wis. All mixing and molding equipment has been designed and built by the company, which states that patents have been issued or are in process for the entire program. The pilot operation at Gisholt is currently capable of producing 4000 lb. of molded products a day. (The tradename for these products is Delwood.) The company is also developing programs that will eventually be licensed to the users on their own premises.

Claims for Delwood include the following: It can be drilled; holds nails, tacks, staples, and screws; metal fastenings can be molded in; it can be doweled like wood; it is moisture-resistant; it has a fracture strength approximating that of hard maple.

**How it is produced.** Rough logs, cut to 4-ft. lengths, are reduced to chips and are then blended into the desired proportions of fibrous glass and polyester resin. The blend is molded in inexpensive cast iron or kel-



**1** First step in production of composite material is feeding of logs through chipping machine. As chips emerge they are conveyed to mixing stations and blended with fibrous glass and polyester resin.

## Die-stamped circuits

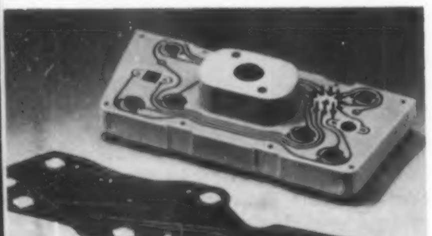
Mass production of electronic circuitry by a newly developed dry process of die stamping the conductor pattern makes it possible to use a wider range of plastics as base materials. No longer does consideration have to be given to the resistance of the base material to etchants—a prime consideration in the wet processes of making printed circuits.

Die-stamped circuits, recently announced by Dytronics Inc., Rochester, Mich., a subsidiary to Taylor Fibre Co., are reported to be already thoroughly field tested and in mass production for a wide variety of automotive, appliance, and control applications and to be gaining acceptance in television and radio sets, computers, and other products requiring electronic and electrical circuitry in large quantities and at competitive prices.

According to Dytronics, the high production rates possible with die-stamped circuits provide substantial reductions in production costs compared with the print-and-etch method; savings of 10 to 40% are claimed.

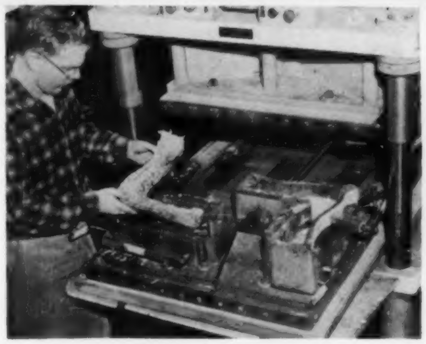
The Dytronics circuits are made by die-cutting the conductor pattern from metal foil which has been coated on one side with a thermo-responsive adhesive and simultaneously bonding the circuit to the insulating base under heat and pressure. Long-life dies can be made, it is claimed, that will permit production runs of up to 4 million circuits without die change.

Since die stamping is a dry process and no excess metal has to be removed by chemical etching, the base material is not degraded by moisture or etchants; neither is there any possibility of any hygroscopic adhesive residue remaining on the base from the excess metal. Die-cutting produces a highly uniform circuit configuration with no cracking, undercutting, or residual copper problems. In addition, the die-cutting action tucks the edges of the metal conductor into the base material, increasing the bond and producing good mechanical and electrical edges. Now, in addition to the laminated plastics that have been predominant in the printed circuit field, circuitry can be economically produced on almost any insulating base material, including vulcanized fibre, and both thermoset and thermoplastic moldings.



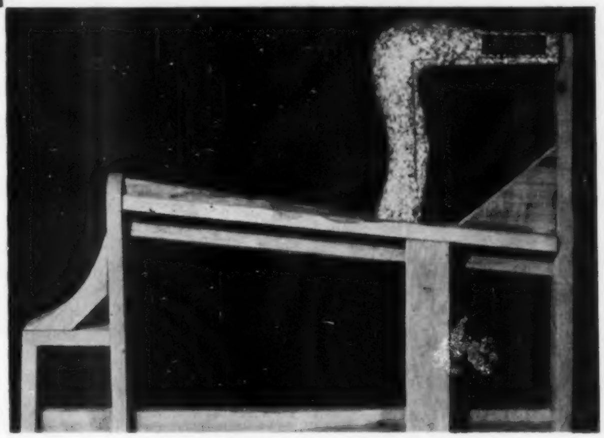
**DRY PROCESS** makes possible die stamping of electronic circuits on wide range of plastics base materials. No etchants are used in process.

**2** Chips are mixed with fibrous glass and polyester resin in pressure chamber to insure full impregnation.



→
**3** Composition is molded on 65-ton presses at pressures of 300 to 500 p.s.i., using cast iron dies. Part is being removed as lower part of mold slides out for easy accessibility.

↓ **4** Frame for wing of chair is molded of composition. Such shaped pieces formerly had to be cut and finished in multi-step wood-working operation.



lered boiler-plate dies on 65-ton hydraulic presses.

Delwood is expected to find early application in the upholstered furniture industry where bulky wooden frame sections can be replaced with lighter, stronger, molded sections. It can also be used as a reinforcing middle-section for table tops, vacuum formed shapes, etc. Through the addition of a flake surface, a finish can be achieved that can be used as it comes out of the mold.

## Fluorocarbon makes better water faucet pistons

Service problems in single-lever industrial and domestic water mixing faucets have been solved by molding one of the moving parts of a sintered fluorocarbon composition. In this type of mixing faucet, which is produced by Gyro Brass Mfg. Co., Westbury, N. Y., a piston that is actuated by a single lever moves within a stainless steel housing to regulate both water flow as well as temperature. Bronze was considered but it had unsatisfactory wear properties; stainless steel expanded when hot water ran through the faucet and bound or seized; standard TFE fluorocarbon also expanded too much and could not be reliably held to required close tolerances.

When pistons were made of the sintered fluorocarbon composition, however, it is reported that they had the desired dimensional stability, long life, oxidation and corrosion resistance, and lubricity; in addition, the material could be cold-molded to the $\pm 0.0003$ in. tolerance that was established by Gyro Brass Mfg. Co.

The composition used is Fluorosint, made by The Polymer Corp., Reading, Pa.; the cold molding is done by Halex Corp., a subsidiary of Polymer.

**(More on page 152)**

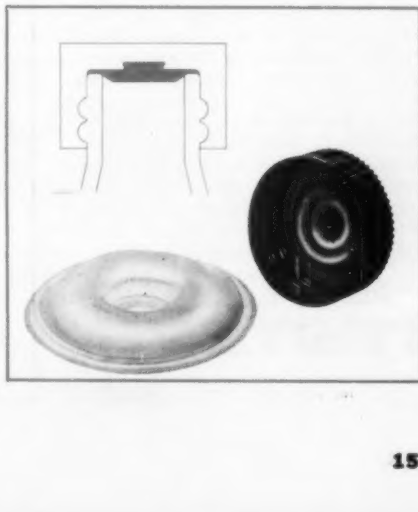
## Soft seals for hard caps

Stated to cost no more than ordinary types, a new molded polyethylene sealer-liner for hard caps on glass and plastics bottles, tubes, etc., is produced in the form of a soft dome-shaped cushion which snaps into the closure and will not fall out.

When a container is capped with this new sealer (see photo, right), the soft polyethylene deforms sufficiently to form a vapor-proof seal which, because it is under tension, prevents back-off of the cap; it also conforms to minor irregularities in the container throat and so eliminates "leakers."

The new polyethylene sealer-liner, called Cushion-Seal by its maker, Gilbert Mfg. Co., Inc., Long Island City, New York, is injection molded, using a 64-cavity mold, at a rate of 3 per minute. It is reported to absorb the shocks of high-speed capping machines, thereby reducing breakage in glass containers.

The material used (Du Pont's low-density PE, Alathon 20) is reported to be tasteless, odorless, and non-toxic.



# NEW DEVELOPMENTS (From page 151)

## Polyethylene molds for biological specimens

Thin-gage polyethylene molds make it easier and more economical to embed biological specimens in blocks of paraffin or cellodin for later sectioning. The molds, much like individual ice cube molds in appearance, have thinned-out corners to make it possible to peel the mold away from the hardened block without disturbing the embedded specimen.

The Peel-A-Way molds are produced from Eastman Tenite polyethylene for Disposable Supply Co., Long Beach, Calif., by Parker Tool & Die Co., Los Angeles, and B. W. Molded Plastics, Pasadena, Calif.

The polyethylene molds, unaffected by the embedding materials or by refrigeration, are available in square or rectangular form for small or large specimens. In use, the specimen is dipped into melted paraffin, placed in the bottom of the mold, and covered with the hot liquid. After the paraffin has solidified, the mold is placed in an ice-water bath or refrigerator. When the embedment has hardened, the sides of the mold are stripped away and the specimen is ready for sectioning. Small interior holding fingers are provided in the molds in which identifying markers may be placed for molding into the blocks.

## Acrylic-styrene for grillework screen

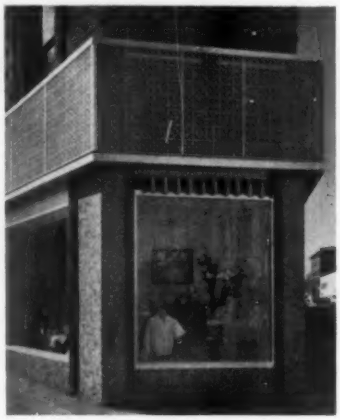
Modernization of commercial store facades with decorative work of costly wrought iron or steel may soon become a thing of the past.

Now available to architects and builders is a grillework screen molded of Zerlon 150, a methyl methacrylate-styrene copolymer material offering good light stability and outdoor weatherability. Cost of the FiliGrille screen, designed and distributed by Holcomb & Hoke Mfg. Co. Inc., Indianapolis, Ind., is said to be ⅓ to ½ of the cost of metal grilles.

Basic component of the screen is an 8-in. module with tongue and groove edges. Larger panels are made by solvent cementing the edges of the modular squares and framing them with anodized aluminum strips.

One of the first exterior applications of the grillework screen has given a new look to 180 ft. of frontage of a Midwest department store. Architects, working with 48- by 56-in. panels, installed the grillework on aluminum tracks just above the display windows. The panels slide on the tracks and can be easily removed for cleaning.

The modular squares are molded for Holcomb & Hoke by Nosco Plastics Inc., Erie, Pa., which uses a 16-oz. pre-plasticizer Watson-Stillman machine. Zerlon 150 is a product of Dow Chemical Co., Midland, Mich.



**SCREEN,** composed of molded Zerlon squares, gives modern look to front of 60-year-old store.

## Heat-shrinking transparent tubing

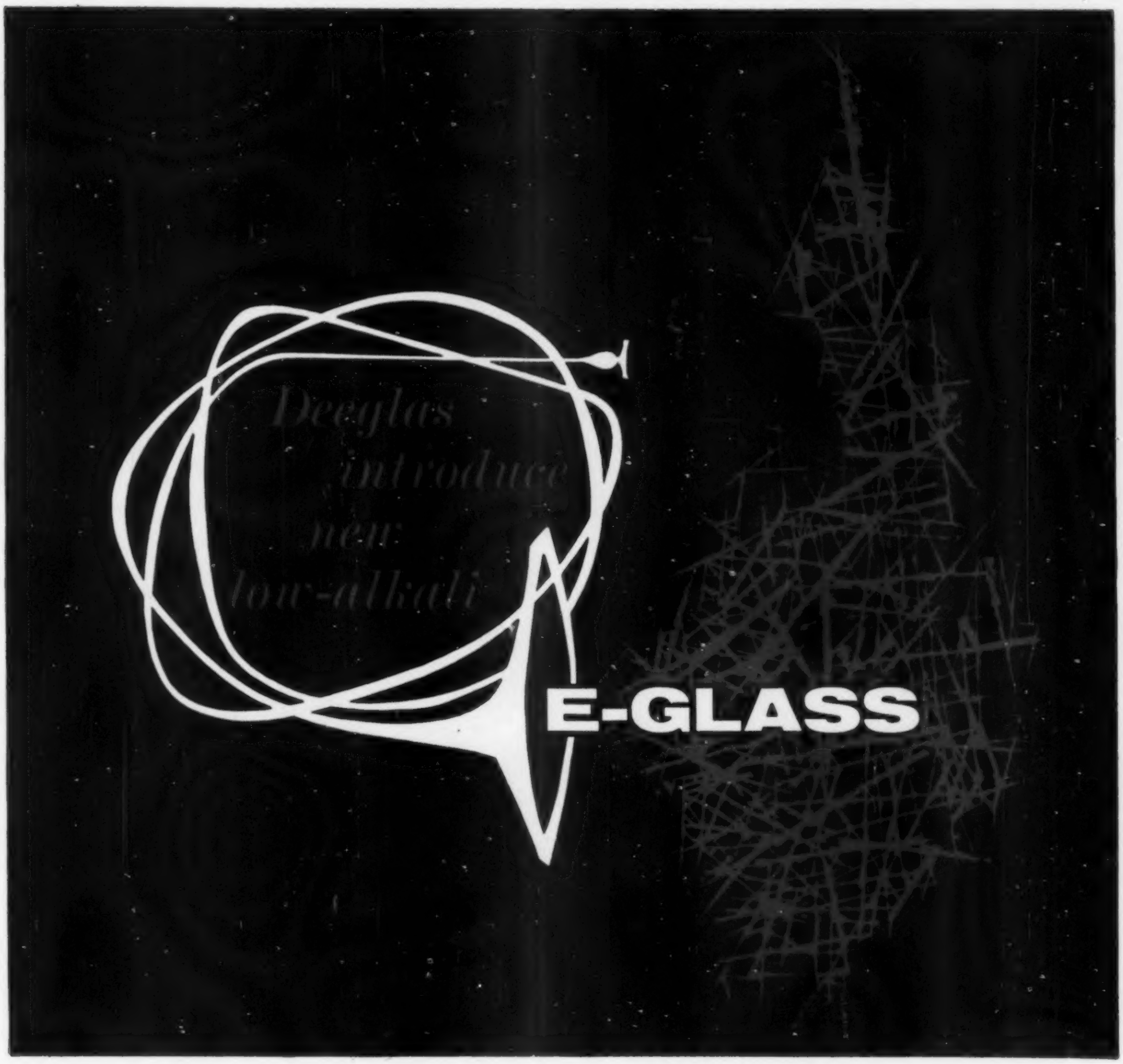
Heat-reactive vinyl tubing, which shrinks under heat to provide a tight covering for either symmetrical or gently contoured shapes, is now available as a clear, fully transparent tubing under the tradename ScotchTite, according to Irvington Div., Minnesota Mining & Manufacturing Co., St. Paul, Minn.

The heat-shrinkable tubing previously has been available as a standard item only in black, imprinted with an identifying Temflex 105 legend.

The new material, designated as ScotchTite brand heat-reactive tubing No. 3025, will also be available in black, unimprinted, or in special colors, to order.

Manufactured under a patented process which pre-expands the tubing, the material shrinks under heat to its normal dimensions in 4 to 8 min. at 300° F. Available for application on objects ranging in size from $\frac{3}{64}$ to 5 in. in outside dimension, the tubing is used for covering harness cables, condensers, coils, ground straps, high voltage leads, bus bars, and other items where a tight, abrasion, and chemical resistant electrical insulating cover is required.

The UL recognized electrical insulating tubing is furnished in continuous lengths, has an electrical strength of 1000 v. in 0.016-in. wall thickness, a tensile strength of 3200 p.s.i., ultimate elongation of 300%; cold brittle point of −20° C.—**End**

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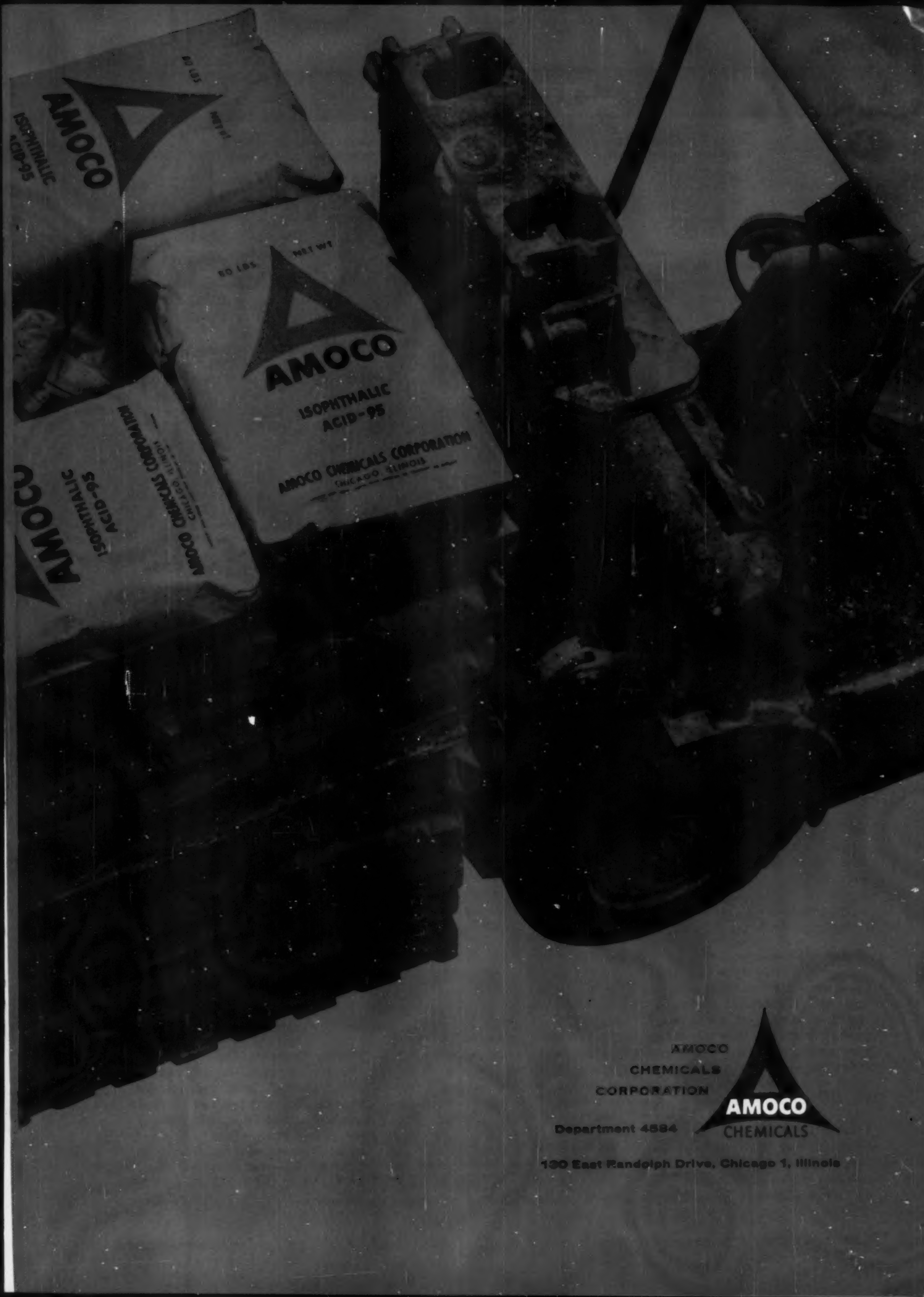
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# LITERATURE

**Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.**

**"Polypropylene,"** *by Theodore O. J. Kresser*

Published in 1960 by the Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. 268 pages. Price: $6.50

Nineteenth in the Reinhold Application Series on plastics, the first 106 pages of the book are devoted to the properties, chemistry, and manufacture of polypropylene. Praiseworthy is the graphical presentation of many of the resin's key properties. Graphs show the variation of these properties with time, temperature, and other conditions acting on the material. The chemistry section explains the structure of the material, the meaning of isotacticity, and the effect of structural factors on physical properties. After brief descriptions of the methods used to process the resin into various finished products, the book goes on to discuss applications of the material in packaging, durable goods, and soft goods. A large part of the packaging section is devoted to the material's application in specific packages for various foods and other items. Potential market estimates are also presented. The final chapter discusses possible future developments. A good introductory round-up of data on polypropylene.—*G.R.S.*

**Extruders.** Specifications, design features, capabilities, etc., for a line of 2½-, 4½-, and 6-in. plastics extruders. Bulletin PM-100. 4 pages. *National Rubber Machinery Co., 47 W. Exchange St., Akron 8, Ohio.*

**Internal mixer.** Machine sizes, batch weights, design features, performance ratings, etc., for the Adamson-Shaw Intermix, which is used to mix plastic and rubber compounds. 6 pages. *Adamson United Co., 430 Carroll St., Akron 4, Ohio.*

**Plastics in Packaging** reviews such packaging considerations as: physical shape, surface printing, choice of materials contributing to the merchandising ability of the package, product protection, costs of package construction, and other factors governing the selection of packaging materials. 14 pages. *Monsanto Chemical Co., Springfield 2, Mass.*

**Catalyst for urethane foams.** Properties, test data, and other technical data for Formrez C-2, a stabilized stannous octoate catalyst for urethane foams. Bulletin F-4P. 1 page. *Witco Chemical Co. Inc., 122 E. 42nd St., New York 17, N. Y.*

**Diallyl phthalate.** Dimensional stability, electrical properties, color retention, chemical resistance, handling instructions, uses, etc., for Dapon diallyl phthalate. 26 pages. *Food Machinery & Chemical Corp., 161 E. 42nd St., New York 17, N. Y.*

**Plastics for Tooling Bibliography,** which was financed by the Research Fund of the ASTME, is a study of the methods of measuring the properties of plastics. It is available in three parts: Part I (Report 5); Part II (Report 15); Part III (Report 29), containing 368 references, covers material published from June 1959 to May 1960. Price: Members, 75 cents for each part; non-members, $1.50, each part. *American Society of Tool & Mfg. Engrs. Research Fund, 10700 Puritan, Detroit 38, Mich.*

**Rod and sheet.** Complete price lists for rigid vinyl, acrylonitrile-butadiene-styrene-type sheeting, high-impact styrene, butyrate, acetate, nitrate, cellulose nitrate rods, cellulose acetate block sheeting, and optical grade cellulose acetate sheeting. 14 pages. *Nixon-Baldwin Chemicals Inc., Nixon, N. J.*

**Blowing agents.** Advantages, toxicity, uses, etc., for Celogen blowing agents for polyethylene, polypropylene, vinyls, rubber, and other materials. 6 pages. *Naugatuck Chemical, Div. of U. S. Rubber Co., Naugatuck, Conn.*

**Procedure for Fabricating Plastic Faced Plasters** outlines four steps that are required for this 2-hr. operation. 2 pages. Bulletin TD-R-111. *Rezolin Inc., 1651—18th St., Santa Monica, Calif.*

**Styrene-acrylonitrile.** Schedule of prices on Tyril for shipments made after Nov. 15, 1960. 4 pages. "Tyril 780" is the title of a 4-page bulletin outlining the physical properties, fabrication data, uses, etc., for a new styrene-acrylonitrile material. *Plastics Dept., The Dow Chemical Co., Midland, Mich.*

**Fibrous glass.** "Johns-Manville Fiber Glass Textile Yarn" describes fibrous glass manufacture from raw materials to eight different types of yarns and textile fibers; physical properties; fiber comparison chart; uses; etc. Brochure FTX-5A. 12 pages. *Fiber Glass Div., Textile Glass Dept., Johns-Manville, 1810 Madison Ave., Toledo 1, Ohio.*

**Rotary knife cutter.** Specifications, advantages, etc., for Model BR 12 by 18 rotary knife cutter, which is designed for granulating thin polyethylene and polypropylene sheets in thicknesses ranging from 0.001 to 0.003 inch. Bulletin 225. 1 page. *Sprout, Waldron & Co. Inc., 130 Logan St., Muncy, Pa.*

**End-Use Markets for High Polymers** is a reprint of the papers read at the Chemical Market Research Assn. 1959 meeting in Chicago, Ill. Price: $5.00. 60 pages. *Chemist Club Library, 52 East 41st St., New York, N. Y.*

**Thermofusion.** Bulletin describes the Engel process for the manufacture of medium- and large-size containers and other structures of thermoplastics (primarily polyethylene). Outlines potential applications, materials, processing data, etc. 4 pages. *American Agile Corp., Bedford, Ohio.*

**Urethane foams.** Physical properties, uses, availability, etc., for Pluracol PeP polyether tetrols, Pluracol TP-340 polyester triol, and 1,2,4-trimethylpiperazine, which are used in the manufacture of urethane foams, elastomers, and coatings; solid polymers; as well as water and organic solvents. 3 pages *Wyandotte Chemicals Corp., 1609 Biddle Ave., Wyandotte, Mich.*

**PVC plastisols.** Formulations, viscosity stability on aging, gel and fluxing temperatures, and other technical data for plastisols made with Paraplex and Monoplex plasticizers. Bulletin MR-19-60. 8 pages. *Rohm & Haas Co., Washington Square, Philadelphia 5, Pa.*

**Plastics Properties Charts** lists specific gravity, tensile strength, elongation, specific heat, compressive strength, Rockwell hardness, thermal conductivity and other characteristics for various thermoplastics and thermosets. One section is devoted to high pressure laminates. 16 pages. *Commercial Plastics & Supply Corp., 630 Broadway, New York, N. Y.*—**End**

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## RP structures

*(From pp. 82-86)*

becomes an integral part of the finished tank when the shell is wound. The tank bottom is chemically bonded and mechanically secured in place on the finished shell after it has been cured.

The winding machines used on the job were designed to incorporate electro-hydraulic sensing devices which maintain a precise carriage-to-mandrel rotation ratio that is necessary to develop a calculated pattern. This system, requiring two to four men as operators, can wind up to 800 lb. of resin and glass per hour. The glass filament—0.000368 in. in diameter—is compounded to standard roving specifications of 12 to 40 ends as needed. Enough roving is fed into the machine to provide the increment of winding required by the pattern.

**Case Study #2:** Perhaps one of the largest single units of industrial equipment ever fabricated from reinforced plastics is the boast of a giant fume scrubber, 47 ft. high and 10 ft. in diameter. Installed in the plant of a metallurgical processing company, the scrubber handles 42,000 cu. ft./min. of dust-laden, highly corrosive fumes (magnesium oxide and fluoride compounds are the main constituents of the flue gases). The structure is molded in sections (by hand-layup) using a fire-retardant polyester resin and chopped glass fiber reinforcements. It is welded together at the site with glass and resin.

Generally speaking, the initial costs of the RP construction ran 1.5 to 2 times as high as standard steel. On the basis of long-term cost, however, the RP construction comes out well ahead. No maintenance whatsoever is required on the RP unit and the service life is considerably greater than the matter of weeks expected of standard steel and the matter of months expected of stainless steel. And the new units weigh only one-seventh to one-tenth as much as comparable steel scrubbers while providing the same structural strength. Lending support to the case for RP is the fact that the scrubbers (a second one is now under construction) will be served by 1000 ft. of polyester-glass ductwork. With growing public concern over the problem of air pollution, scrubbers of this type may yet develop into substantial large-volume markets for reinforced plastics.

**Case Study #3:** A fibrous glass-reinforced polyester (a bisphenol A resin) tank, 10 ft. high and 10 ft. in diameter, is being put to use in a processing operation involving a mixture of dilute hydrochloric acid, sulfuric acid, and other ingredients at temperatures up to 180° F. Of paramount importance in the switch to the reinforced plastic tank is the fact that it will stay in service for about 10 years—without any repairs! The total outlay for the metal tank previously used for the job, when figured on a 10-year basis, ran to something like *six times the expense* of the plastic unit. And over a five-year period, the metal tank's maintenance costs alone equalled the purchase price of the plastic tank.

Downtime, a costly headache, has also been completely eliminated. The lead-lined steel tank used previously had to be drained and aired periodically. This operation required a crew of "lead burners" to enter the tank, burn or scrape off the corroded areas, and reline them with lead. The burning operation, in itself, was a potential fire hazard. In contrast, minor leaks in the reinforced plastic tank can be blocked by a temporary patch on the outside surface of the tank (the patch is simply fibrous glass mat laid in place with liquid resin). Then, during the next lull in production, a permanent patch can be installed. No downtime—no costly waiting!

It is interesting to note that the tank had to be designed to withstand rapid temperature changes, to support a load of more than four times its own weight, and to accommodate 18,000 lb. of lead piping. Yet when the construction engineers had finished with the job, the plastic tank weighed only 3000 lb. —½ the weight of its predecessor.

**Case Study #4:** As used by Molybdenum Corp. of America to replace stainless steel units, 200-ft.-high fume stacks are being made in sections of a phenol-formaldehyde resin filled with acid-digested asbestos fiber. They are used in a molybdenum oxide production unit (in a combination flue dust recovery system and fume **(To page 161)**

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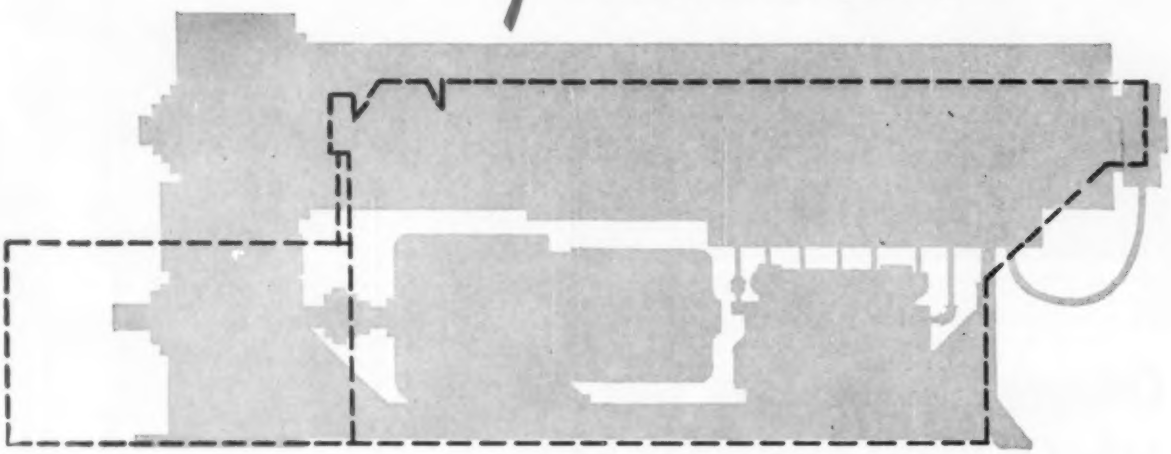

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scrubber) that had been plagued with corrosion created by the formation of sulfurous acid in up to 5% concentrations. Under these conditions, stainless steel stacks previously used lasted about eight months; under the same conditions, the reinforced plastic stack is now entering its seventh year of service —and no failure yet!

The costs involved present an interesting picture. At the outset, the user of the RP stacks was faced with product costs that ran twice as high as they would be in metal (the RP stack costs $25,000, structural steel scaffolding and installation added another $25,000; metal stacks, on the other hand cost only $20,000 plus $5,000 for installation). Yet on the basis of the extended service it affords, the reinforced plastics tower pays for itself at the end of 16 months of operation!

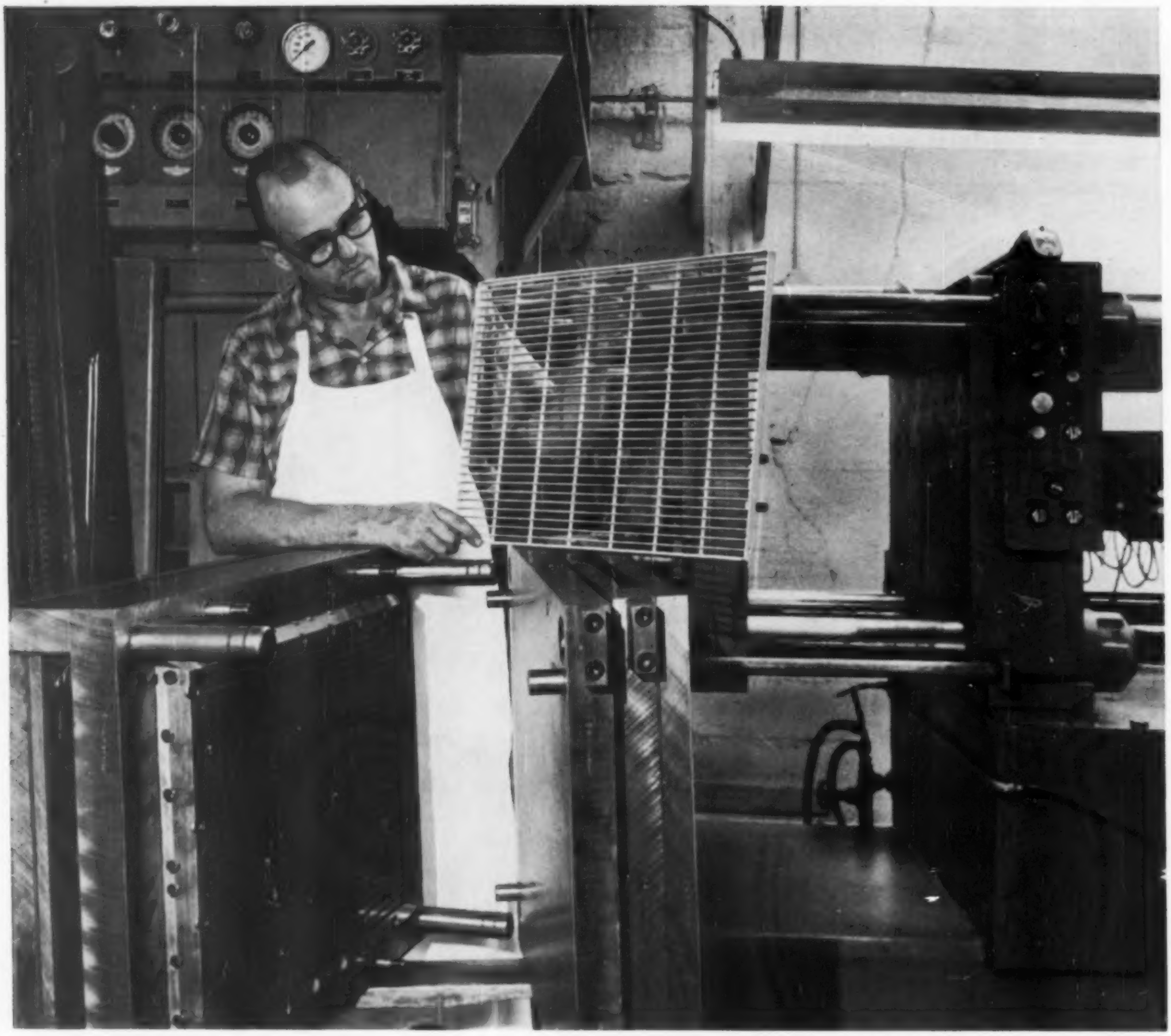
**Case Study #5:** Huge fan housings of reinforced plastics are becoming virtually standard equipment for industries involved with corrosive materials. Unlike the simple cylindrical shapes of the tanks and ducts, these housings involve more intricate design. Typical is a fan housing recently erected at a processing plant dealing with large quantities of battery acids. Standing 11 ft., 4 in. high, 11 ft., 10½ in. wide, and 5 ft. deep, the giant housing handles approximately 60,000 cu. ft./min. of corrosive sulfuric fumes. The housing is molded in sections (to facilitate shipment and to allow for easy installation of the impeller) by hand lay-up of polyester-glass and is easily bolted together in the customer's shop.

Prior to the adoption of reinforced plastics, the processing plant depended on coated metal housings. Maintenance problems were severe, however, requiring the periodic full-time services of a maintenance crew to cut out corroded areas, weld in new plates, and sand blast. And plant engineers tried virtually every type of coating, including tars and pitches, in unsuccessful efforts to solve the problem. In the reinforced plastics structure, the answer was finally found. There were by-product advantages as well. One was the reduction in weight—a factor that could be of much importance if circumstances call for the housing to be mounted on the roof of the building.

**Case Study #6:** A series of polyester-glass and epoxy-glass tanks, in capacities up to 2000 gal. and now in use in chemical plants, paper mills, and food processing installations, offers these impressive cost savings figures: 5 to 20% less than rubber-lined steel tanks and 10 to 60% less than stainless steel tanks. And this despite the fact that the molder of the tanks uses a steel cable to carry hoop stresses (a continuous cable is anchored at top and bottom of the tank and rides freely in slotted vertical seams). The tanks are molded in sections in open-faced molds by either hand lay-up or by spray-up techniques. They are joined together in the field by a cold-set process in which fibrous glass mat or cloth impregnated with a catalyzed polyester or epoxy resin forms the joint. Cure is at room temperature.

This means, of course, that the reinforced plastics tanks can be erected safely even in limited spaces and in hazardous areas since no open flame is required. Service life of the tanks is effectively infinite and the initial investment is the only cost. The tanks are also claimed to be over 250 times better than mild steel for use as a thermal insulator.

**Case Study #7:** Another application lending weight to the case for filament winding as an applicable technique for industrial structures is the reinforced plastic bottle designed for gas/air storage. With an inside diameter of 51 in., the bottle is capable of holding 300 gallons. It is still being used by a branch of the military for an as-yet classified application—but commercial concerns are very much aware of its possibilities. Like the tank described on p. 86, the bottle is made by winding a continuous fibrous glass filament impregnated with polyester resin around a hollow spherical core. In this 51-in. dia. container, the fabricator used 1,340,000 miles of glass filament. Containers of this type, formed with great-circle windings to place all filaments in pure tension, will provide tensile strengths of 150,000, making the containers especially suited for applications where pressures are involved. Tests have veri-



# Plastic grille for air conditioner molded in a breeze with **Lustre-Die**

One every minute! That's how rapidly this plastic grille for an air conditioner was molded at Midwest Plastics Corporation, Wichita, Kansas. Using a die made of Bethlehem Lustre-Die tool steel, they produced a perfectly formed grille each time—and with a high sheen. The grille measures 21½ x 15 in., and is ½ in. thick.

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fied that the actual stress in the glass fibers is nearly 200,000 p.s.i. at rupture.

### *A question of design*

There are, of course, limitations in the use of giant reinforced plastics industrial structures. Size is one. When you get up to a real "blockbuster," such as a 500,000-gal. tank 54 ft. in dia. and 14 ft. deep, reinforced plastics lose much of their economy and practicality. But the problem can be easily sidestepped as it was for the 500,000-gal. tank by installing a steel or concrete shell —and *then* using a reinforced plastics liner.

There has been some discussion, too, about the question of reinforced plastic's lower modulus of elasticity in the larger tank sizes, but most current producers of such tanks feel that technology has been sufficiently advanced in the past five years to permit tanks to be built and designed (e.g., with molded-in stiffening ribs) around this limitation. Hardly any producers thus far have felt it necessary to go to metal for stiffening members (the manufacturer of the tank described on p. 86 is one of the few that have swung in this direction).

Justin Enterprises Inc., Cincinnati, Ohio, for one, feels that cable wrap is unnecessary. ". . . We are achieving hoop strength with straight reinforced plastics construction that result in safety factors of 10 and up."

T. F. Killeen, Exec. Vice-Pres. of du Verre Inc., states his position this way: "We do not sanction metal bracing or cables on tanks shipped in one piece up to 11½ ft. in diameter. Over this size, the conventional technique would be to use the same construction as on silos or barrels (*e.g.*, hoops or rings). Most of us in the industry, however, are designing away from metal and, in many cases, we can strengthen by design or use the type of glass reinforcement that will give us the strength needed. Almost any strength required can be achieved by proper glass selection."

R. E. Barnett of Haveg Corp. feels, too, that by using the right construction (*e.g.*, composite constructions with outside layers of oriented high tensile strength fibrous glass reinforcement), the laminate will provide sufficiently

high strengths. The problem with locally-reinforced areas lies in the build-up of stress which, in time, would become significant as adjacent areas lose strength. The key is to create a structure so that every increment of surface area is uniformly strong.

### The future

Judged by processor's analysis of the market, the future for large reinforced plastics industrial equipment looks bright. There is much research and development going on now aimed at improving the technology. This is taking place not only in industry itself but also in such areas as missiles and rocketry which have already laid the groundwork for many of today's uses.

As this new technology becomes available, coincident with the greater acceptance of reinforced plastics construction, fabricators will be able to insure industry of an even more satisfactory product. It will be possible to design with more realistic safety factors than are now necessary to fill in the unknown gaps in fabricating techniques. Thus, the cost picture will be greatly improved—and application potential consequently increased.

*Credits:* **Case Study #1:** Poxyglas tanks made by Black, Sivalls, and Bryson Inc., Kansas City, Mo. **Case Study #2:** Fume scrubber designed and engineered by Buffalo Forge Co., Buffalo, N. Y.; fabricated by du Verre Inc., Arcade, N. Y., using Hetron 92 fibrous glass-reinforced polyester (Durez Plastics Div., Hooker Chemical Corp., N. Tonawanda, N. Y.). **Case Study #3:** RP tank fabricated by Carl N. Beetle Plastics Corp., Fall River, Mass., using Atlac 382 bisphenol A polyester resin supplied by Atlas Powder Co., Wilmington, Del. **Case Study #4:** Fume stack designed and installed by Haveg Corp., Wilmington, Del. **Case Study #5:** Fan housing designed and made by Heil Process Equipment Corp., Cleveland, Ohio. **Case Study #6:** RP tank segments manufactured by Metal-Cladding Inc., N. Tonawanda, N. Y. **Case Study #7:** Filament-wound RP bottle made by Apex Reinforced Plastics Div., White Sewing Machine Corp., Cleveland, Ohio.

For their assistance in developing background material, the editors of MODERN PLASTICS wish also to thank: William R. Wardrop, Metal-Cladding Inc., North Tonawanda, N. Y.; E. W. Vereeke, Heil Process Equipment Corp., Cleveland, Ohio; Arvid H. Edwards, Black, Sivalls & Bryson Inc.; and H. E. Friedrich, Buffalo Forge Co., Buffalo, N. Y.—**End**

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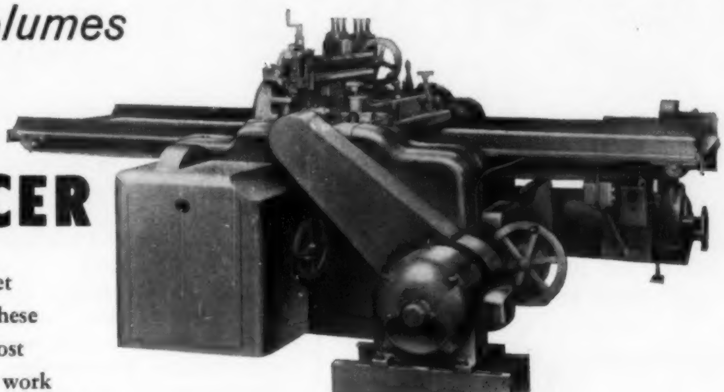

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## Fluorescents

*(From pp. 88-90)*

of a solvent may be desirable to obtain the proper viscosity for coating (organosol). Mineral spirits, aromatics, diisobutyl ketone, or mixtures of these ingredients are recommended as useful. A minimum of solvent should be used. Solvent addition is the last step that is necessary in preparation of the organosol.

The following suggested formulation has been successfully used in the preparation of a 3- to 4-mil-thick cast vinyl film of exceptional fluorescent brightness:

| | |
|---|---|
| Vinyl resin QYNV (Union Carbide) | 39.7 parts |
| Dioctyl phthalate | 11.9 parts |
| Dioctyl adipate | 11.9 parts |
| Paraplex G-62 (epoxy) (Rohm & Haas) | 2.0 parts |
| Mark LL (Ba-Cd stabilizer) (Argus Chem.) | 1.2 parts |
| Fluorescent pigment | 25.3 parts |
| Socal 2 (Standard Oil Co. of Calif.) | 4.0 parts |
| Socal 3 (Standard Oil Co. of Calif.) | 4.0 parts |
| | 100.0 |

Products being made of fluorescent-pigmented vinyl plastisols include the following:

**Marine mooring buoys** (Offered in a choice of several colors, including fluorescent red and yellow, the buoys may be seen from a long distance, even under overcast or cloudy conditions (See MPI, Oct. 1960, p. 96);

**Playballs** and related items. ("Our experience with fluorescent colors in vinyl balls has been outstanding," states A. J. Gordon, who is the vice president in charge of sales, The Barr Rubber Products Co., Sandusky, Ohio.);

**Plastisol-coated fabrics** (gaining acceptance for safety clothing for hunters and construction workers, traffic markers, warning signs, display banners and pennants used by filling stations).

### How to color polyethylene

A number of items injection molded of polyethylene (PE) are now making their appearance with fluorescent colors, and others are in the development stage. Since the light stability of these pigments in polyethylene is substantially less than when used with vinyl plastisols and organosols, it is advisable to select products, such as toys and housewares, which will not be continuously exposed to direct rays of the sun.

One toy manufacturer uses fluorescent red in a line of wheeled toys. He reports that the reaction of retailers throughout the country has been good. The firm purchases the PE material already colored with the fluorescent pigments.

One pigment supplier recommends the following percentages of fluorescent color pigments for molded PE articles to obtain good color effects:

| *Thickness* (mils) | *Pigment* % |
|---|---|
| 3 to 5 | 15 to 30 |
| 10 | 8 to 15 |
| 20 | 4 to 8 |
| 40 and over | 1 to 4 |

This table emphasizes the necessity of using much higher percentages of pigment for thinner articles. Molding temperatures of 375 to 400° F. are recommended by this supplier. Since some decomposition of the pigments begins to take place at around 400° F., it is recommended that dwell time in the heating cylinder be kept to a minimum. If molding is interrupted for any considerable period, the cylinder should be purged to avoid discoloration of subsequent moldings.

At present, some interesting development work is being done with blow-molded linear PE bottles having fluorescent coloring. Such containers would offer striking display possibilities at the point of sale. For this type of application, the dry blending technique is reported to work out quite satisfactorily, producing containers with highly uniform color dispersion.

Advertising specialties, such as rulers, letter openers, etc., as well as auto windshield scrapers, refrigerator storage containers, fish scalers, signs and point-of-sale items are among other products being injection molded of various thermoplastic materials incorporating fluorescent pigments.

### . . . and polyester

In addition to various thermoplastics, the fluorescents have also been used to some extent with polyester resins. One supplier of

pigments offers the following as a workable formulation:

| | |
|---|---|
| Laminac 4131 (Am. Cyanamid) | 100 parts |
| Fluorescent pigment | 5 parts |
| Uvinul D-49 (Antara Chem.) | 1 part |
| 50% Benzoyl peroxide paste | 2 parts |
| Laminac promoter 400 | 2 parts |

The promoter should be mixed in only after the peroxide has been dissolved in the polyester resin, otherwise, a violent reaction might easily occur.

According to this pigment supplier, polyester resins of the vinyl toluene-modified type work out most satisfactorily with its pigments. Other modifications of the polyesters, including the styrene-modified type, are said to dissolve the pigments and thus yield parts having much poorer light stability. Mixed pigment and polyester should be used within one day of the time they are mixed, since the long-term effect of the liquid polyester on the pigment has not been determined.

The technology of using fluorescent pigments in plastics products is fast developing—and the gaps in knowledge that now exist are now being filled in. Along with these developments is a steady increase in their use in a broadening range of plastics which can benefit a great deal from the inherent functional or merchandising coloration of these pigments.

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Manufacturers of plastics items using fluorescent pigments mentioned in this article include: **acrylic numbers and letters**—Precision Plastics Products Inc., Chicago, Ill.; **plastisol marine buoys**—Oshkosh Plastic Products Inc., Oshkosh, Wis.; **plastisol playballs**—The Barr Rubber Products Co., Sandusky, Ohio, and Eagle Rubber Co., Ashland, Ohio; **toys**—Plastic Toy & Novelty Corp., Brooklyn, N. Y., and Reliable Toy Co. Ltd., Toronto, Canada; **safety garments and other plastisol-coated fabric products**—Cooley Inc., Pawtucket, R. I., Haartz-Mason Inc., Watertown, Mass., Albert W. Pendergast Safety Equipment Co., Philadelphia, Pa., and Aldan Plastics Co., also Philadelphia.

**Acknowledgment:** For supplying valuable information for this article, MODERN PLASTICS gratefully acknowledges the efforts of these suppliers of fluorescent pigments: Lawter Chemicals Inc., Chicago, Ill.; Radiant Color Co., Oakland, Calif.; and Switzer Bros. Inc., Cleveland, Ohio.—**End**

## Nylon housing

*(From pp. 95-97)*

models it is attached near the spray nozzle—a cumbersome arrangement that interferes with easy gun handling. The simplified design is accomplished by casting the nylon around stainless steel tubing to form a unitized handle-housing component.

According to a company spokesman, this could not have been done economically with a metal-housed gun, because of the complex machining operations which would have been necessary. An additional advantage attributed to the use of glass-filled nylon is the material's outstanding corrosion resistance in the face of contact with a number of different exterminator fluids.

Six products of five manufacturers do not mean that nylon is going to pre-empt the appliance housing market. But the fact that, in each case, the manufacturer felt that nylon offered one—or more—advantages at a cost competitive with other materials is strong indication that nylon's market base may well be substantially broadened in the years ahead.

*Credits:* **Shick shaver:** Fosta Nylon 6 (polycaprolactam, general purpose) supplied by Foster Grant Co., Inc., Leominster, Mass.; moldings by Consolidated Molded Products Corp., Scranton, Pa., and American Insulator Corp., New Freedom, Pa.; **Millers Falls drill:** Zytel 31 (nylon 6/10) for housing, and Delrin for lock switch and collar, supplied by Du Pont Co., Wilmington, Del.; Lexan polycarbonate for chuck supplied by General Electric Co., Chemical Materials Dept., Pittsfield, Mass.; housing molded by Nylon Products Corp., affiliate of F. J. Kirk Molding Co., Clinton, Mass.; **Portable Electric soldering gun:** Housing of Plaskon (polycaprolactam) nylon supplied by Plastics Div., Allied Chemical Corp., New York, N.Y.; molding by Plastic Masters Inc., New Buffalo, Mich.; **Supreme can opener and clipper:** Spencer Nylon 401 (polycaprolactam) supplied by Spencer Chemical Co., Kansas City, Mo.; molding by Plano Molding Co., Plano, Ill.; **B&G spraygun:** Nylafil G-3 (glass-filled compound based on Plaskon 8200 nylon from Allied Chemical Corp.) supplied by Fiberfil Corp., Warsaw, Ind.; molding by U.S. Gasket Div., Garlock Packing Corp., Camden, N.J. —**End**

## RP trailer

*(From pp. 92-94)*

Oddly enough, however, none of these out-size monsters gave any real trouble on the production line.

### *A sandwich construction*

Production of prototype parts for the Holiday House began as soon as the first mold was cured and trimmed. Parts generally are 1-in. thick and are fabricated of two skins with a paper core in-between. The skins are laid up in three plies of fibrous glass, impregnated with polyester resin and cured at room temperature.

The paper 'honeycomb' core is not a true honeycomb, for it does not contain the familiar cell pattern. Rather it is composed of three plies of paper, two of which are skins bonded to the third so that the finished core takes the form of a corrugation or sine wave. Many variations of the product are available, in both impregnated and unimpregnated papers. One of the impregnated paper cores, used in an actual part and cut into test specimens, survived more than 100 p.s.i. in both compressive and flex tests, and 11,000 p.s.i. in edgewise compression. Little difference was observed in behavior of specimens parallel to or across the core ribbon. The actual material selected for this particular job was a core ¾ in. thick, composed of face papers of 97-lb. kraft, bonded to a core ribbon of 60-lb. kraft; paper stock was not impregnated prior to use.

The process of fabricating prototypes was standard. The mold is cleaned, waxed, spray-coated with a mold release agent, and brush-coated with a polyester gel coat containing a color suitable as a base for the final paint job. Fibrous glass cloth was laid on the gelled surface and impregnated with resins, applied with brush and squeegee. The paper core was then placed on the tacky surface of the laminate and held under pressure from a PVA vacuum bag until the laminate skin and core were bonded together.

The PVA bag was then removed carefully (if it is in good condition, it can be used again) and the second skin was applied to the exposed surface of the paper core. Some parts were then re-bagged for final cure at vacuum pressures

while others were cured as a contact layup. The decision is determined by the ultimate structural values desired in the finished part.

Wood inserts were used in window opening areas and in most of the joints to facilitate final assembly; they provide a familiar and convenient means of attachment for screws, bolts, etc.

### *Finishing operations*

An early stage in assembly of the body shell is shown in the photo on p. 94. The front panels, the street side panel, and half of the rear are bonded to the plywood deck. The curb-side aft quarter panel and small roof-support side panels were installed later.

Final assembly of the prototype shell was achieved with the bonding of both roof panels to sidewalls and to each other at the centerline joint. This is the longest bonded joint in the trailer and is reinforced with two strips of aluminum, ⅛ by 5 by 240 in., one inside and one outside. These elements are bonded and bolted in place.

Although bolts pass through the structure from skin to skin, forming potential points of moisture condensation, the problem was solved by bonding a decorative ceiling over the joint area.

### *Many advantages*

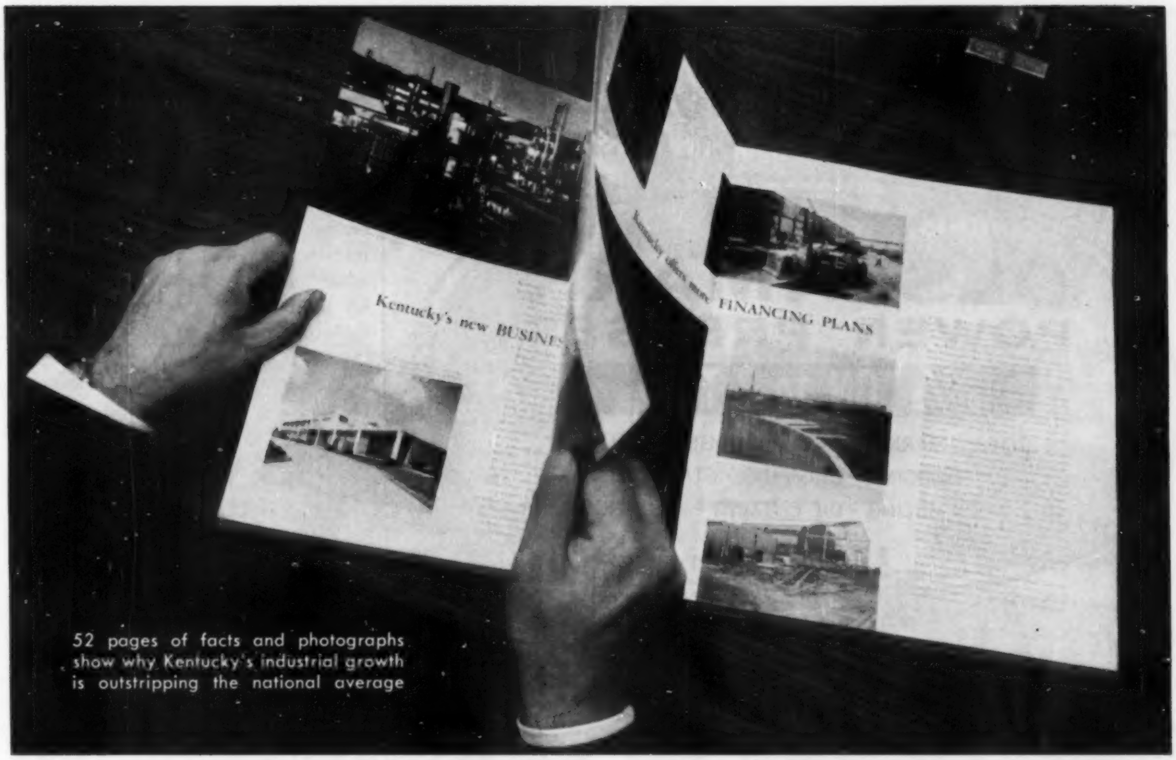
Thermal properties of the structure are generally superior to conventional aluminum-and-wood construction. Convection within the sandwich is very slight, due to the closed-cell construction of the core. Conduction through the glass laminates and the thin web of the paper core is low. Radiation is reduced by the smooth exterior surface and light colors.

Three thousand man-hours after work started on the patterns, the completed molds were shipped to Holiday House Inc. at Medford. Material costs exceeded $15,000. Direct materials used in patterns, molds, and the finished reinforced plastics parts accounted for perhaps three quarters of that sum. The remainder went for tools, supplies, etc.

The plastic body shell of the 24-ft. Holiday House weighs, on an average, 15 oz./sq. ft.—considerably less than conventional trailer shells. The weight thus saved makes it possible for Holiday House to carry such interesting features as refrigerated air conditioning as well as a wholly independent electrical system.

When the finished RP trailer finally rolls out the door this month, it will be testimonial to the fact that aircraft and military principles aimed at solving the complexing problems of strength-weight ratios *can* be put to work in competitive consumer markets—even where the company has not had any previous experience with reinforced plastics. It may be just the right kind of encouragement that is needed by those industries that are now contemplating (and perhaps fearing) plastic developments of similar magnitude.

*Credits:* Trailer design by Charles W. Pelly; molds by Industrial Design Affiliates, Beverly Hills, Calif.; epoxy tooling resins and polyester laminating resins supplied by Reichhold Chemicals, Inc., White Plains, N. Y.; glass cloth, woven roving, and polyester gel coat supplied by Ferro Corp., Nashville, Tenn.; paper core material from Verticel Co., Littleton, Colo.—**End**

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## Decorate in the mold

*(From pp. 98-99)*

four years ago in Europe. At that time, French, and later Italian, molders developed it to compete with standard decorating methods involving costly hand-finishing operations or the molding of a recess into the frame and then cementing a laminate sheet into the recess. The U. S. debut of insert decorating took place in 1960 primarily for use in sunglass frames.

Molders in other industries—particularly packaging and ornaments—however, have seen the possibilities and are adapting the idea to their own.

Among the first to go beyond eyeglass frames was Colt's Plastics Co. Inc., North Grosvenordale, Conn. The product: a polystyrene cosmetic jar with an acetate cap. In making the jar, a decorative styrene laminate is first cut to a rectangular shape which, when formed into a cylinder, duplicates the outside dimensions of the jar. This "cylinder" is then inserted into the mold cavity. Because of the elasticity and "plastic memory" of the laminate, the cylinder snaps out as soon as it is inserted and clings to the circular walls of the cavity. No adhesive backing is used and Colt's reports that the job was successfully run on a horizontal injection molding machine.

For the acetate cap of the jar, an acetate laminate die cut to fit snugly into the bottom of the cap mold cavity is used.

From a study of the cosmetic jar, it is obvious that the new technique is not limited to flat shapes, or to any one material. When working with polyethylene, butyrate, vinyl, polypropylene, etc. laminates based on these materials are available for insert decorating. It is important, of course, that the molding resin and the laminate sheet be compatible. With versatility like this, we can expect to see the technique being adapted by many molders of thermoplastics.

The information presented in the above article is based on data provided by Leathertone Inc., Boston, Mass., a supplier of decorative laminate sheets. Leathertone is one of the pioneers who developed and introduced the insert decorating technique in this country.—**End**

## Traffic markers

*(From pp. 100-101)*

marker is 5½ ounces. Once installed, traffic wear simply exposes more reflective beads, maintaining reflecting efficiency.

Buttons are permanently bonded to the pavement by a specially formulated epoxy adhesive. About 16 cc. (about 1 cu. in.) of mixed adhesive (epoxy plus hardener and filler) are required for each marker on rough surfaces, and 12 cc., or ¾ cu. in., on fine-grained concrete. Once installed, bond strength is such that the button cannot be removed without damaging the road itself. The California Highway Department has not yet specified the new marker on asphaltic concrete, but has limited its use to portland cement concrete highways, pending study of test installations on asphaltic concrete made by its Materials and Research Dept.

Designated Bottsdot (in honor of Dr. E. D. Botts, until his recent retirement Senior Chemist at the California State Div. of Highway Materials and Research Lab. Dr. Botts, assisted by H. A. Rooney, present Senior Chemist, developed the bonding formulations and was active in the developmental work), the markers are furnished in kit form, each kit containing 100 traffic markers, 6 lb. of adhesive, 1 templet for adhesive, 1 wire brush and 1 mixing spatula. Cost in quantities of 50 kits is $45 per kit (reflectorized), $36 per kit satin finish. Bulk prices (22,600 and up), are 30¢ per reflectorized button, 18¢ for satin finished buttons.

To date, close to 60,000 buttons have been installed on California freeways. As these markers prove themselves, many other users will undoubtedly follow suit.

*Credits:* Buttons designed and developed by BOTTS-line Inc., Redwood City, Calif.; molded by Woodside Industries Inc., Redwood City, Calif., of polyester resin supplied by Reichhold Chemicals Inc., White Plains, N. Y.; bonding adhesive compounded by Adhesive Engineering, Div. of Hiller Aircraft Corp., San Carlos, Calif., from resins supplied by Ciba Products Corp., Fair Lawn, N. J.—**End**

The California specification referred to in this article gives an alternative for the button construction as follows: Epoxy-polysulfide polymer type: epoxy resin (epichlorohydrinbisphenol); polysulfide polymer, and non-yellowing hardener—27% minimum; glass spheres—54% minimum; titanium dioxide, 17% minimum. As far as is known, no such buttons have actually been installed on California highways, except for experimental installation using laboratory-produced markers.

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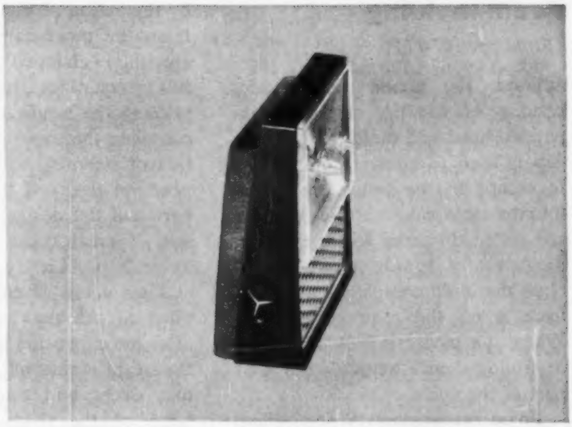

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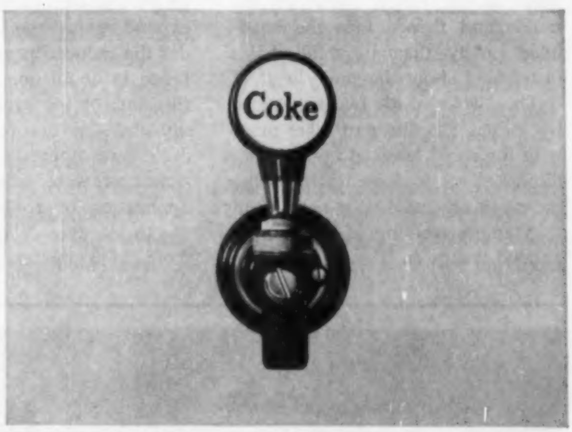


**TYPE F**—*highest heat distortion temperature, good impact strength. Used in vending machines for valves and canisters.*

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## Foam molding

*(From pp. 107-112)*

amount, the actual distance depending on the size of the pre-expanded bead and mold design. This gap is used to allow the filling air to escape as the beads are blown into the mold, and must be precisely controlled. In order to set the gapping exactly, it was found best to close the mold completely and then back it off the required amount. When the cavity is full, a sensing or timing device actuates the next part of the cycle.

**Foam expansion.** When filled, the mold is ready for the expansion of the foam. The mold drains are closed and steam pressure is applied to the steam chests of the molds and thence into the bead-filled cavity through small holes distributed about the cavity wall.

The "weld" cycle is divided into two parts. The first part takes place with the mold cracked open (as in filling). This is done to allow the escape of any residual moisture and to promote welding of the pre-expanded beads at the parting line by the action of the steam escaping from the mold cavity. The molds are then clamped shut and the full pressure of the steam is applied to the beads in the cavity, to complete the expansion. The duration of steaming will of course depend on the wall thickness of the part and the design of the part itself. Typical times are shown in Table 2, p. 112.

**Time delay.** If cold water is applied to the molding too quickly after the expansion is complete and the steam is shut off, thermal shock may occur and cause partial collapse of the foam structure. To prevent this a delay is provided after the weld cycle to allow for the release of steam pressure and to permit the foam to completely expand against the cavity walls under the reduced pressure which has fallen to about one atmosphere. In this part of the cycle, the steam is off and the drain valves on the mold are opened to release the steam pressure prior to the full application of cooling water. The length of the delay is anywhere from 1 to 10 sec. and will vary with the characteristics and density of the foam.

**Cooling cycle.** To prevent distortion of the part from further expansion after it is removed from the mold, the surfaces of the part must be cooled well below the expansion temperature and sufficient heat must be removed from the center sections of the molding to prevent residual, internal expansion pressures from bulging or cracking the cooler outer walls of the part. Although the lower temperature of the item for satisfactory ejection depends on the design of the item itself it should be somewhere below 120° F. Since polystyrene foam is an excellent heat insulator, the cooling cycle time is often the largest percentage of the total time required for the overall cycle. Various methods are used to cope with the cooling problem; both water sprays within the steam chest and flood techniques are used. If flood water is used, the steam chamber is filled with water with the mold drains closed. After the mold is filled with water at about 55° F. the mold drains are opened and water

is circulated through the steam chest until the required cooling is complete.

Sprays are used where extra cooling is required, such as in mold pockets and blind cavities which could not be reached with a through flow of water. Spray cooling is not often used in molds which have steam chest contoured to follow the cavity wall since contouring is generally adequate to distribute the through flow of water to all parts of the cavity.

In some cases a vacuum of about 25 in. of Hg. is used to aid the cooling process. This is particularly done with molds designed to produce high-gloss areas. To produce a "glazed" surface on a foam part the mold surface at that point must be highly polished and must be operated at a temperature of about 230° F. Since the steam required is at 270° F. and at a pressure which would collapse the foam if it were injected directly into the cavity, these sections of the mold's steam chest are isolated from the mold cavity proper and have no steam injection holes. This type of construction is illustrated in Fig. 5, p. 110, which shows the mold for an ice bucket. Since the steam in these areas does not enter the mold, high pressure steam can be used to develop the required "glazing temperature." Other sections of the cavity operate off the standard type of steam chest which is used to admit low pressure steam for the final expansion of the pre-expanded beads. After expansion has taken place, the non-cavity-connected high pressure steam chambers are flooded with water to provide cooling in the "glaze" areas. In the low pressure steam chambers, which are connected with the cavity proper, a vacuum is applied, and no water is admitted. The vacuum accomplishes two things. First, it provides a cooling effect on the foam since the residual low-pressure steam in the foam is sucked out and the condensate evaporates under the vacuum providing a cooling effect. Second, since the foam cavity is under a vacuum, the foam in the glazed areas makes better contact with the polished mold surface, helping to produce a better gloss on the foam molding.

The correct use of vacuum cooling with indirect water cooling of the mold will often speed up the molding cycle and more than offset the extra cost that is involved in the construction of the multichambered mold.

**Ejection.** After cooling is complete, the press opens and the foam part is ejected. This can be done by either using air jets which blow the piece out of the mold or by a pneumatically or mechanically operated set of ejector pins or bars. The ejection system is usually actuated by the movement of the opening platens through the use of a **Microswitch.**

For a fully automatic system, the positive system of bars or ejector pins is preferred, although the construction of molds for this method is more expensive. (The extra expense arises from the need to provide guides for the ejector pins and sealing them from the steam chest to prevent the escape of steam or cooling water). The positive system is desirable to insure that parts are

definitely out of the mold area between the platens before the next cycle starts. In addition, so that parts need not be manually cleared, molds are mounted on vertical platens moving horizontally, causing the moldings to fall free of the machine after ejection. This also allows the use of a conveyor belt under the press to transport parts to a packing station or other operations automatically.

### *Estimating cycle time*

It is possible to accurately estimate cycle times involved in the molding of expandable styrene. This was not as important in manual molding operations, since the molding rate was primarily dependent on the operator rather than on the molding machinery. Because of the human element that is involved, cycles could vary widely and it made little sense to spend time in making accurate estimates of machine cycle time.

However, in automatic molding, the production rate of the process is no longer dependent on the operator; and it is important from the standpoint of quoting on jobs to be able to estimate foam molding cycles with accuracy. Table II presents typical cycle times as a function of part thickness and can be used for general estimating. Actual cycles thus will vary with the part and mold design involved. Some understanding of the molding problems is necessary and will be helpful in using the table.

As can be seen from the table, there are three major factors which determine the foam molding cycle. These are 1) the time it takes to fill the mold cavity, 2) the time it takes to inject the steam for expansion, and 3) the time it takes to cool the product and remove it from the cavity.

**Filling time.** Filling time will depend on the volume of pre-expanded beads which must be loaded into the cavity and the rate at which the material can flow into the cavity. This in itself sounds very simple but in fact it is not so, as the material is not pushed into the mold cavity, but pulled in by a continuous flow of air in the filler pipe which passes through the cavity and out of the cracked mold. With the type of filling device described and all other conditions constant, it has

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been found that a cavity for a part with a heavy wall and an easy flow pattern will fill in half the time required for a part of equivalent volume but which has thin walls and a more complex geometrical shape. Thus in calculating fill time, both the volume of the part and its geometrical complexity will have to be taken into account. Fig. 6, p. 112, presents data on filling times that are measured on a typical foam mold.

Density of the pre-expanded beads will also affect the filling time. Fig. 6 shows how filling time varies with density and the air pressure used in the filling device. It is not possible to discuss all the details and the relationship of all the variables affecting mold filling time in this article, but the data presented will give the reader some idea of the feasibility of calculating filling cycle for any product irrespective of size, density, etc., if all the data is available.

**Weld or expansion time.** The data presented in Table II give some idea of the variation in weld time with part thickness. Again, the complexity of the mold, the foam density required, and other factors relative to the design of the product will have to be considered before an accurate prediction of the weld time can be made. However, the maximum and minimum times which might be expected for parts with the wall thicknesses shown are given in Table II. For the purpose of estimating costs, the longest time is taken and unless the design of the mold is not well planned, it should be possible to complete the expansion of the foam within the time shown. It is important to note that the quality (moisture content) of the steam can markedly affect the curing time of polystyrene foam. Tables showing the quality of steam at various pressures and temperatures are readily available in various engineering handbooks and it is not feasible to include them in this study.

**Cooling time.** In cooling, the design of the mold is often of greater importance than it is to the proper fill and expansion of the foam itself. Except in very thin wall items, the cooling time often exceeds the sum of both the filling and weld times taken together.

Basically, the mold should be so designed as to provide each surface of the cavity to be cooled with an adequate supply of cooling water. The water should pass over these sections in an inundating fashion, covering them completely. This provision for adequate cooling refers also to such sections as the bottom of the mold. Do not depend on conduction through the mold from one section to another. This is a slow process which takes precious cycle time.

Another important factor is the temperature of the cooling water entering the mold. The most satisfactory temperature is sufficiently low to cool the product fairly fast and yet not so low as to cause shock cooling of the foam molding itself. For most applications this temperature is about 55° F. To assure adequate circulation of this water through the molds a water pressure of approximately 80 p.s.i. is required.

The unavailability of either the proper temperature water or of sufficient water pressure may result in poor molding efficiency when using an automatic molding press similar to the one that is mentioned early in this article.

Typical cooling times used in automatic foam molding for items of various wall thicknesses are shown in Table II.

### *Conclusion*

With the development of automatic equipment for the molding of expandable polystyrene foams, it is expected that the economies which result from automation will allow the foam molder to compete on a broader basis with other plastic molding processes for new applications. At present, the initial cost of automatic foam molding equipment is relatively high. A suitable press for this type of operation costs about $40,000. With all the required accessories to run a completely automated line, the total cost of such a line runs about $45,000 exclusive of tooling. However when one considers the increased speed of operation and the ability to handle long run jobs, the initial cost of the equipment can be quickly amortized and unit piece costs are entirely in line. It is expected that automated foam molding will quickly find a variety of applications.—**End**

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**MOLDING COMPOUNDS.** 4-page folder describes epoxy molding compounds. Chart gives comparative properties of general-purpose thermoset materials—including flexural strength, psi . . . modulus of elasticity . . . impact strength, etc. General information, other data. The Fiberite Corp. (101-B)

**PROPORTIONING, MIXING, DISPENSING.** 6-page illustrated brochure describes line of air-powered equipment for exact proportioning, mixing and dispensing of two-component, chemically reactive materials. Exclusive features listed, specifications, other data. Gray Company, Inc. (102-B)

**INDUSTRIAL MACHINERY.** 8-page illustrated booklet describes polyurethane foam production equipment and special industrial machinery—including slab lines, traversing units, squeeze roll units, etc. General information, specifications, other data. Leon Machine & Engineering Co. (103-B)

**DISPERSING-MIXING UNIT.** Illustrated brochure describes dissolving machines—wide variety of models from 30 gallons to 1,000 gallons. Ultimate dispersion in fraction of time required by ordinary machines, increased output, etc. General information, specifications, other data. Morehouse-Cowles, Inc. (104-B)

**PLASTIC MOLDING PRESSES.** 4-page illustrated folder describes line of automatic rotary plastic molding presses—10 and 30 station capacities—that offer hopper feeding, continuous rotary operation, high speed production, wide flexibility, etc. Full information, specifications, other data. New England Butt Co. (105-B)

**PLASTICS EXTRUDERS.** 8-page illustrated brochure describes 3½ in., 4½ in., 6 in. plastic extruders that offer a greater thrust and horsepower capacity, versatile modular construction, space-saving, tuck-under drive. Induction and resistance heated models, with either liquid or air cooling. Advantages, specifications. National Rubber Machinery Co., Extruder Div. (106-B)

**MOLDING MACHINES.** Catalog provides engineering data on complete line of plastic injection molding machines. Full information on machines of varying capacities, complete specifications, outstanding advantages and other data listed. Newbury Industries, Inc. (107-B)

**THERMOSETTING PHENOLICS.** 14-page illustrated booklet describes line of phenolic molding compounds, phenolic industrial resins and melamine and other modified phenolic thermosets. Advantages include dimensional stability, moisture resistance, chemical resistance, etc. Specifications, applications, other data. Plastics Engineering Co. (108-B)

**STATIC ELECTRICITY.** Illustrated folder describes aerosol bomb spray that offers simple, quick, effective relief from static electricity to the printing industry and other fields. Statikil, Inc. (109-B)

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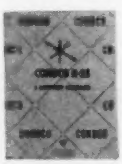


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## Extruder design

*(From pp. 114-120)*

heat generated in the magnetic clutch at low speeds. The overall speed range is primarily 17:1.

Variable-speed drives must be selected with care in order to avoid overstressing reducer gears or extruder feed screws. Constant torque units should be matched with allowable torsional loads at top speeds (Point A in Fig. 4) and at maximum horsepower. Constant horsepower units should be selected on the basis of the maximum torque which can be delivered, consistent with the extruder's requirements. The best reference point is usually the base motor speed (Point B on Fig. 4), which frequently occurs in the middle third of the speed range.

Belt-connected drives should also be analyzed with the torque-horsepower characteristics in mind. It is equally important to select belts on the basis of the maximum torque which is to be delivered (Point B or Point A in Fig. 4.)

### *Heater system*

Through the years, designers have moved in many directions in the design of electrical heating systems for extruders. Among the first heater designs, were the thinly sheathed, flat strip heaters which were preformed to fit the barrel and then clamped into position on the outside of the cylinder. Careful installation and reasonable, periodic attention to keeping the heaters tight on the cylinder, resulted in what has been considered acceptable life and performance. However, reliability of these heaters has not been entirely satisfactory and some units have been susceptible to failure after a moderate life span.

More recently, tubular- or rod-type heaters have been used. These are cast into aluminum blocks which jacket the extruder barrel and have come to be identified as "cast-in aluminum heaters." The thermal conductivity of the aluminum diffuses the heat from the tubular heaters embedded in it and provides more even heating of the extrusion cylinder than was possible with the strip type heaters. These heaters have served effectively in recent years and have demonstrated long service life and

a remarkable degree of durability against mechanical abuse.

In the past few years, induction heating has also been seriously considered for use on extruders. This method of heating, which has found enthusiastic followers in the metal heat-treating industry, is now enlisting advocates in the extrusion field. Big obstacle to its more widespread use in the heating of extruder barrels is its initial cost. If the means can be found to incorporate induction heating systems on extruders at costs competitive with cast-in aluminum heaters, it may very well become *the* heating method to be used in the future. Cast-in aluminum heaters will probably be with us for a long time, representing as they do the best solution to the problem of heating extruders at a reasonable cost.

### *Cooling systems*

Many types of cooling systems are currently in use on extruder cylinders. One of the simplest is the air cooling system which makes use of fans and blowers. Blower cooling arrangements are adequate for a moderate amount of heat dissipation, and are particularly suited for automatic cooling control.

However, when large amounts of heat must be dissipated rapidly, liquid or vapor cooling systems are generally more effective. In principle, a liquid system is effective in providing accurate control when the flow rate can be precisely regulated. A good way to control the flow precisely is to dilute or restrict the liquid flow by introducing a pressurized gas or vapor. This provides the operator with the ability to use either 100% air or water or any combination to get the degree of cooling desired.

Most systems being designed today aim at cooling controls that do not "shock" cool the extruder. Generally, there is a trend to operate extruders adiabatically, and cooling is used just to the extent of keeping excess heat generated in the working of the material by the screw from running away and causing erratic operation of the extruder.

### *Other machine components*

With all the various types of feed an extruder may be called upon to handle (film, chopped sheet, dry blend powders, pellets,

etc.) it has been found that a rectangular feed throat positioned tangentially with respect to the feed section of the screw is the most effective and convenient. Also desirable in feed throat designs is a generously sized opening which will permit the incorporation of gland type seals for hot melt feeds and help to minimize bridging of material in the throat.

In addition to concern with the strictly functional components of an extruder, designers are also giving attention to the over-all appearance and design. Sometimes both considerations coincide.

For example, when hopper design was considered at Waldron-Hartig, the industrial designer suggested that the hopper be made with a rectangular cross-section rather than with an exactly square cross-section, which was then current. When the rectangular design idea was considered in detail it was found that not only was the appearance of the hopper improved, but its capacity increased as well.

Another engineering plus arising out of efforts to improve the appearance of the machine resulted from the suggestion that the controls be centralized to facilitate the operation of the extruder. Carrying the idea a step further, a centralized control unit was developed that could be mounted either on the major control unit or on the extruder. This led to an increased flexibility in locating the equipment in the shop. (See Fig 5, p. 120).

Finally, a reconsideration of the shape and layout of extruder parts within the unit has led to the redesign of the extruder base, which in addition to making it easier to build the extruder has also resulted in a more sturdy foundation.

It is safe to say that with increasing competition among extruder manufacturers and with the need to meet ever changing problems, there will be a constant effort to improve extruder designs further. Ever increasing demands from the extruders are certain to assure this in the coming years. Although the simplicity of an extruder may lead one to the cynical assumption that extruder design has little further to advance, the improvements that have evolved in recent years refute this and indicate that there is much yet to come.—**End**

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## Shrinkage of polyesters

*(From pp. 123-132)*

application of pressure tends to eliminate this problem. The presence of uniformly distributed fillers tends to reduce this tendency towards forming shrinkage pools.

**Fiber exposure, fiber prominence, external fiber blush.** Exposure or prominence of fibers on the surface of the cured piece is caused mainly by the great difference in the linear expansion coefficients, *i.e.*, by thermal shrinkage between the glass and the resin. While the "E" type glass has a linear coefficient of expansion of $2.8 \times 10^{-6}$ per °F., that of polyester resins is 50 to 60 $\times$ $10^{-6}$ per °F. (19). On release from the mold, the surface resin, since it cools at a faster rate than the inner portions, has approximately a 10 to 20 times greater thermal shrinkage than the glass fibers. This shrinkage causes the resin to recede into the surface leaving the glass fibers completely exposed or covered with only a thin layer of resin. The thinner the protecting skin of resin on the glass fiber, the more easily will the glass be exposed to the action of weathering, erosion, postbaking, and degradation. Also, much greater stresses are built up in the resin-glass interface of the surface layer. If the piece is not sufficiently cured while under pressure, the fiber exposure will become more pronounced due to certain factors, such as continuing chemical shrinkage, the presence of residual monomers which have a high vapor pressure at the existing molding temperatures, and incomplete reinforcing bonds between the resin and the glass. Postbaking of undercured pieces will further the tendency of the resin in the surface to recede from the glass fiber, due to the additional chemical shrinkage, repetition of thermal shrinkage, and the aforementioned causes.

Weathering also contributes to fiber exposure. Solar radiation, both ultra-violet and infra-red, promotes the continuance of cross-linking in the glass-reinforced polyester. This effect becomes visible by the exposure of the glass fibers at the surface of the piece, yellowing, internal fiber blush, and in extreme cases crazing. The resin layer covering the glass fibers at the sur-

face is very thin. Postshrinkage, such as occurs by the action of ultra-violet and heat, causes the resin layer to shrink away from the fibers. A very small amount of shrinkage is sufficient to cause the fibers to be exposed. Fiber exposure can also be caused by friction, erosion, hydrolysis, or decomposition of the resin.

There are several methods to reduce or prevent the exposure of glass fibers in the surface. The application of sufficiently thick gel coats has been recommended (20), the fiber pattern decreasing with increasing gel-coat thickness. Another method used by some manufacturers is to apply a resin layer on the release sheet and cause it to gel before bringing it in contact with the wet lay-up. Also, by coating the mold with an even coat of resin and allowing it to set before proceeding with the molding, a smooth surface can be produced.

When the piece is made more resistant to fiber exposure by applying a coat of resin, it is important that this coat is of even thickness but not too thick. Uneven coat thickness makes the construction of the piece unbalanced and this can lead to warpage (21). Too thick a coating may cause cracking, due to the difference in shrinkage between the coat and underlying base material. Addition of fillers to such coating resins is recommended where possible, since they reduce the aforementioned shrinkage differences and they also are found to greatly improve the resistance of the surface to fiber exposure. Also, the application of a crinkle finish tends to improve the resistance to fiber exposure. It may be expected that modifications in the polyester resin will, in the near future, greatly improve this fiber exposure deficiency.

**Flexural strength.** Smith and Carson (14) reported that the flexural strength of laminates usually increases with shrinkage (Table VII, p. 131). These authors conclude "that the increase in laminate strength with resin shrinkage would tend to support the theory that a frictional attachment beween resin and fiber is largely responsible for laminate strength, since the frictional force is proportional to the product of resin shrinkage (induced by both polymerization and thermal changes) and modulus of

elasticity. Thus, for best laminate properties, polymerization shrinkage should be as high as possible without being great enough to cause internal stresses in the resin which would lead to cracking."

Direct data showing the relationship between flexural strength and cast resin is not available. But it has been shown that the flexural strength of cast resins depends on both the mole percent of maleic anhydride and the weight percent of styrene (Table VIII, p. 132). Wood (13) also published data showing that the flexural strength of castings is related to the ratio of moles of styrene to moles of maleic plus fumaric anhydride. In Table VIII, the flexural strength increases up to about 40 mole % of maleic anhydride (and/or fumaric acid). Best results appear to be obtained with a resin containing about 40% (molar) of maleic anhydride (and/or fumaric acid) and 20% (wt.) of styrene. Thus, the flexural strength in laminates is highest when the shrinkage is high, but in castings the strength properties appear to decrease after a maximum is reached. Of course, it is possible that the strength of the laminates may also pass a maximum in a region not as yet explored. The relationship between shrinkage and percent polymer and monomer unsaturation has been shown earlier (Table VII).

There are other determinants affecting flexural strength, such as glass content, directionality of test, fiber finish, type of monomer, filler content, molding conditions, and the chemical structure of the polymer backbone. These are beyond the subject of this paper.

**Internal stresses.** The glass-reinforced polyester resin system is ideally suited to build up internal stresses. In general, the higher the shrinkage of the resin the greater the tendency to create internal stresses. As Chambers and McGarry (22) have pointed out "appreciable stresses are created when liquid resins are cast and cured around glass elements. The parameter most influential on the stress magnitude is the temperature cycle experienced during polymerization; the lower the exothermic peak, the lower is the pressure between the glass and resin at room temperature since the difference in thermal expansion coefficients is largely responsible for the creation of pressure." According to these investigators, such residual pressure may be in the order of 500 to 2000 p.s.i. at room temperature.

The thermal shrinkage of the resin is 10 to 20 times greater than that of the glass. Chambers and McGarry indicated that the chemical shrinkage may not be an important parameter in the creation of the pressure between resin and glass. This internal stress created mainly by the high thermal shrinkage of the resin against the glass may very well explain the great "reinforcement" encountered in the glass-reinforced polyester. Smith and Carson (14) had also explained this reinforcement as caused by both chemical and thermal shrinkage, using the term "frictional attachment."

Although this creation of stress as caused by shrinkage in the vicinity of glass fibers promotes quality, there are other stresses

created in the cured system that are detrimental. Thus, uneven distribution of glass in the resin causes uneven shrinkage, which may lead to deficiencies such as crazing, internal fiber blush, formation of shrinkage pools, and waviness of the surface. Also, if the ratio of resin to glass is too great, say 85:15, such defects may also be produced. Further, uneven thickness of the piece tends to cause uneven shrinkage, which may result in warpage. In extreme cases the increased exotherm in these thicker areas and the consequent excessive shrinkage may also produce cracking and internal fiber blush. The correlation between exotherm peak temperature and wall thickness of the piece is shown in Table IX, p. 132. Internal stresses can also be produced in thin panels if the gel coat exhibits substantially different shrinkage properties than those of the underlying polyester.

Another cause for the formation of internal stresses is found when the piece is cooled too quickly. The shrinkage increases with the rate of cooling. If this rate is too high, a surface film of higher density may result while the inner piece may be lower in density. In general, internal stresses are higher the greater the rates of reaction and the less uniform the construction.

**Light transmission.** Apart from the factors of refractive index, color, glass fiber finishes and binders, plasticizers, fillers, etc., the light transmission of glass-reinforced polyester panels is influenced by the shrinkage of the resin (23). Thermal shrinkage plays an especially important role. Generally speaking, the smaller the difference in the thermal expansion (shrinkage) coefficient between the glass and the cured resin, the higher the light transmission (17). Water in the filler or glass fiber also increases the coefficient of thermal expansion and thus the shrinkage. This applies particularly when the curing temperature exceeds the boiling point of water under the given pressure conditions. The influence of the relative humidity of the air on the percent light transmission is shown in Table X, p. 132.

Light transmission decreases rapidly when the cure temperature exceeds the boiling point of water. This is ascribed to the occurrence of "microporosity," caused by the evaporation of the water in the system. Figure 7, p. 132, demonstrates the relationship between light transmission and microporosity (17).

The decrease of light transmission with press temperature has been recently demonstrated by Smith and Carson (14). Excessive shrinkage may result in voids and internal fiber blush, which also greatly reduce light transmission.

**Warpage.** Warpage is caused by nonuniform shrinkage. It takes place in the following forms (19): bowing of box shapes, springing forward (*i.e.*, closing inward) of angle shapes, diagonal torsional distortions of flat areas, and "oil canning" of flat areas. Methods to counteract this phenomenon have been described by Sonneborn (19). They consist essentially of reduction of shrinkage, balanced lay-up of the reinforced systems, and correct mold design. Nonuniform distribution will tend to warp constructions towards the **(To page 201)**

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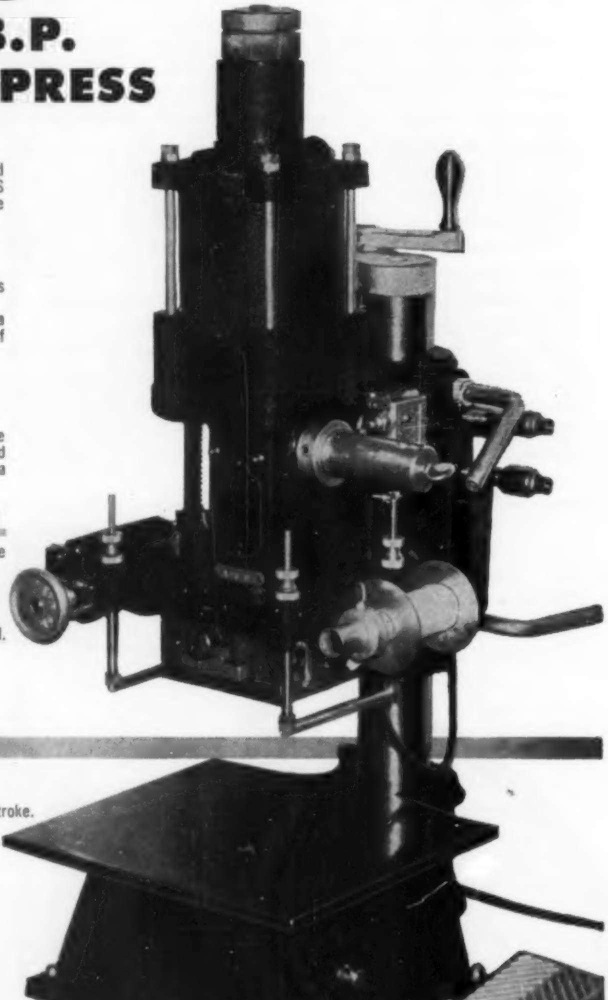

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**STATIONARY TABLE:**
12" x 11"

**AIR PRESSURE:**
Not less than 2 h.p. compressor — 80 lb. pressure equipped with 60 gallon tank. Compressor not supplied.
Pressure approximately 19 times line pressure.

**ELECTRICAL:**
110 volts A.C., unless otherwise specified.

**SHIPPING WEIGHT:**
220 lbs. Net, 270 lbs. Gross
Head size: 4" x 5"
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Chase size, inside: 3" x 4"

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lubricator, regulator, strainer and 6 ft. of hose.

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resin-rich side. Also, low-temperature cure and slow, uniform cooling are found to be helpful.

**Water resistance.** In addition to the quality of the resin, type of glass finish and type of glass used, water resistance can also be influenced by shrinkage. In general, reduced shrinkage increases the water resistance (19) or, conversely, increased shrinkage increases the water absorption. It has recently been shown (14) that the water absorption is increased with increasing press temperature. This is believed to be due to the greater shrinkage occurring at higher temperatures. If excessive shrinkage causes cracking, formation of voids and internal fiber blush, water absorption proceeds with relative ease.

One major effect of internal fiber blush is that the resin shrinks away from the glass fibers, thus creating fine cracks in the resin-glass interface. This causes the water resistance to decrease rapidly. In order to eliminate this tendency of the resin to shrink away from the glass, it has been found possible to shrink the resin onto the glass fiber by starting the polymerization on the glass surface. This can be accomplished when the glass fibers are treated with a peroxide prior to resin impregnation (17).

**Waviness of the surface.** This phenomenon is generally observed in moldings that have been cured at low pressure or under no pressure at all. The resin has a greater tendency to shrink away from the surface into the piece, while the fiber remains on the surface. This becomes more apparent the less dense the fiber structure in the surface. This effect can therefore be reduced by using a finely-knit surfacing mat. Also, slow-cure tends to improve this condition. Slight pressure in the order of several p.s.i. usually helps to eliminate waviness. Any reduction in shrinkage, i.e., by the use of fillers, a low shrinkage resin, etc., will also reduce this phenomenon.

### Conclusions

Evidently, the cured glass-reinforced polyester system contains a multitude of sources for the creation of stresses largely due to differences in local shrinkages. The main cause for the build up of stresses is nonuniformity, *e.g.*, non-

uniformity in the glass distribution, in the ratio of resin to glass, in the rates of reaction, in the rates of heating and cooling (as caused by the differences in thermal conductivity between the mold, the glass fibers, the resin, and the fillers), in local pressures inside the cured piece, and non-uniformity of thermal shrinkage on cooling of the piece because the outer skin cools much more quickly than the interior part. Consequently, it appears that substantial quality improvements may be expected when an increase is made in the degree of uniformity of material distribution, rates of reaction, and rates of heating and cooling. In view of the low thermal conductivity of the resin, the overall cycle usually must be as long as is possible.

Not all internal stresses are detrimental. There is considerable evidence that during the curing process high pressures, of the order of 500 to 2000 p.s.i., are built up in the resin-fiber interfaces. This effect is due to the shrinkage of the resin around the glass. It explains the greatly enhanced strength properties of the glass-reinforced system when compared with cast pieces that do not contain glass. This and other effects, such as the fast decrease in laminate strength in pieces in which voids are formed in the resin-glass interfaces, make it likely that the reinforcing bond between the resin and the glass is in a large part due to the shrinkage of the resin around the glass. Of course, the glass-resin bond of the cooled piece is also determined by other factors, such as the type of glass finish, the type of bonding resin, the quality of glass, etc. Apparently both chemical and thermal shrinkage play a major role in the formation of the "reinforcing bonds."

In spite of the large amount of valuable data published so far, more knowledge of the quantitative relationships involved is needed.

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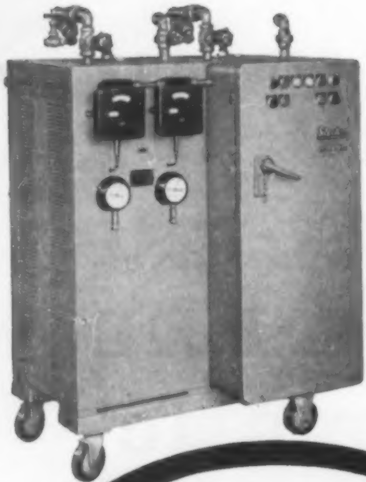

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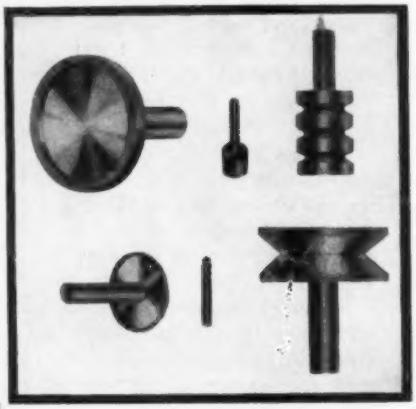

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575 Madison Avenue New York 22, N.Y.

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**WEIGHT-BEARING WAYS** —The Ingersoll Milling Machine Company, one of the largest builders of specially designed machine tools, are particularly well known for their milling and boring machines. These machines are built in a range of sizes up to mammoth proportions. The phenolic laminated plastic ways shown above are used at the bottom of machine tables to prevent scoring of metal-bearing surfaces under their heavy loads. The plastic ways also reduce fitting time. Some of these machines have a capacity for carrying upwards of two hundred tons on the table in addition to the weight of the table. The laminated plastic ways were supplied by the Panelyte Division of St. Regis Paper Company and made with Mount Vernon Duck.

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## Thermoset plastics

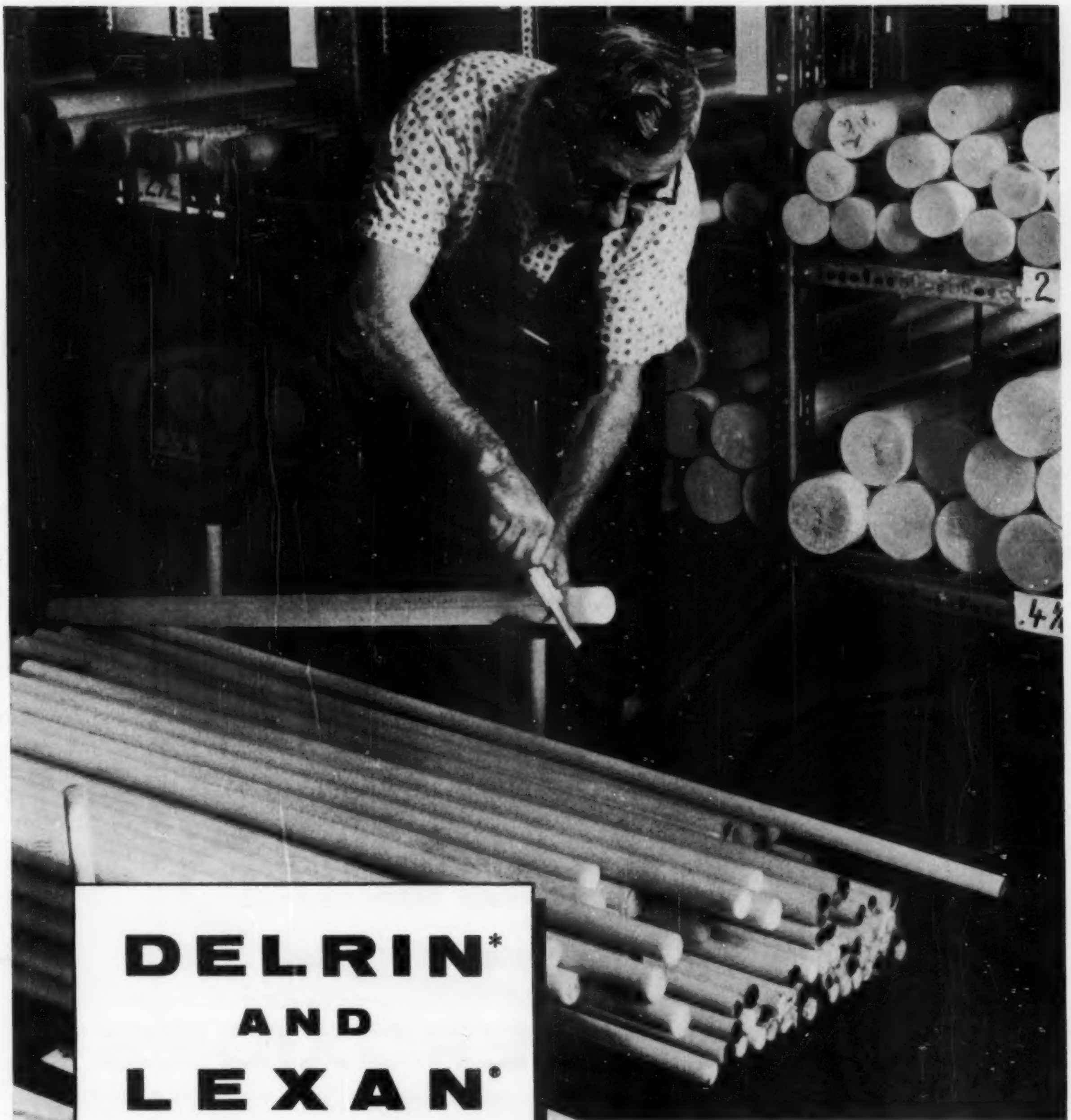
*(From pp. 134-147)*

doubled every 10°C. and the rate-time curves were either straight lines or showed a gradually increasing curvature convex to the time axis. These latter rate curves were calculated from the volatilization-time curves; either the maximum rates or the initial rates obtained by extrapolating the rate curves to zero time were used in calculating the activation energies[2] by means of the Arrhenius equation. In the case of the polyester, such a procedure could not be followed because the curves are irregular in shape (Fig. 4, p. 145) and are irregularly spaced. The method used for the polyester consisted in calculating rates for various temperatures at points where two or more time-volatilization curves are intersected by the same horizontal lines, corresponding to various percentages of volatilization, in the range of 18 to 26 percent. The results of these calculations and other pertinent data are shown in Table VII, p. 145. The activation energies calculated on the basis of the data given in this table appear to increase from 36 kcal./mole at 18% volatilization to 58 kcal./mole at 26% volatilization. These values were obtained from the slopes of the straight lines in Fig. 5, p. 147.

**Epoxy.** The percentages of volatilization of the epoxy resin measured with the spring balance are plotted as a function of time in Fig. 6, p. 147. The rates of thermal degradation as a function of percentage volatilization are shown in Fig. 7, p. 147. The pertinent experimental details are given in Table VII. By extrapolating the linear parts of the rate curves in Fig. 7, the apparent initial rates are obtained. The activation energy for the epoxy resin, as calculated by means of Arrhenius' equation on the basis of these initial rates, is shown by the slope of a straight line in Fig. 5 and is equal to 51 kcal./mole.

**Phenolic.** Rates of degradation for the phenolic resin were measured at 355, 380, and 420° C. in the tungsten spring balance, and at

[2] Use of the term "activation energy" in connection with the polyester, epoxy, and phenolic resins described in this paper is only in a sense that the rate data are treated as if these materials were well-defined chemically and the kinetic processes were simple. However, this is not entirely so, as indicated under "**Materials.**"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331.5° C. with the electronic balance. Experimental details and results are shown in Fig. 8, p. 147, and Table VII. In a manner similar to that used for the polyester, rates were determined at the intersection of the time-volatilization curves with the 7%-loss horizontal line. Only the 355 and 380° C. curves could be paired. The 331.5 and the 420° C. curves could not be included with the other two curves, as can be seen from Fig. 8. The activation energy based on these calculations amounted to 18 kcal./mole, and is obtained from the slope of the straight line in Fig. 5. This approximate value for the activation energy of phenolic resin is unusually low in comparison with that of the other polymers of this investigation.

**Silicone.** This resin degrades very slowly, as can be seen from the curve in Fig. 3. In order to obtain any rate data for this resin, a temperature of at least 800 to 1000° C. would have to be used. Neither rate apparatus available could be used at temperatures above 500° C.

Because of the high percentage of crosslinking in the polyester, epoxy, and phenolic resins and the tendency to lose side groups in the resin, the thermoset plastics yield on pyrolysis a nonvolatile residue. Using the amount of this residue at any given temperature as a measure of thermal stability, the order of stability of the four is: silicone > phenolic > polyester > epoxy.

In the case of the silicone, the Si-O bonds in the main molecular chain have a higher energy value than the Si-C bonds in the side groups (8), so that the backbone remains more or less intact while the side groups break off. Judging from the fact that in the analysis of volatile products from the silicone (Table V) hydrogen, methane, and benzene appear in large amounts, some of the carbon in the side groups becomes dark because of the carbonization (see Table I).

The phenolic resin undoubtedly owes its high thermal stability to its highly crosslinked nature and to the resonance caused by the presence of benzene rings in the structure. The lower thermal stabilities of the polyester and epoxy resins are most likely due to lower degrees of crosslinking. The polyester, epoxy, and phenolic resins yield on pyrolysis considerable amounts of CO and $CO_2$. The ratio of CO to $CO_2$ increases with rise in temperature of pyrolysis. This agrees with the reaction $C + CO_2 \leftrightarrows 2CO$, in which formation of CO is favored at higher temperatures.

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# THE PLASTISCOPE*

News and interpretations of the news — By R. L. Van Boskirk

**Section 2** *(Section I starts on p. 39)* — **February 1961**

## Good year ahead for the plastics industry

"Whether a recovery occurs in the spring or it takes until summer, the momentum of the plastics industry should produce at least a 10% gain in volume over 1960," says Harry M. Zimmerman, head of Seiberling Rubber Co.'s Plastics Division.

"Plastics are leading today's product revolution. They're invading markets never before thought possible, simply because of their phenomenal behavior. There may be concern by some industries about prospects for the immediate future, but in plastics, everything's coming up roses. Nothing short of a major depression will stop this wholesale market penetration."

The general manager of the Seiberling division says total production of synthetic plastic and resin material this year "will almost double" the 3.7 billion lb. marked up in 1955, the year Seiberling entered the plastics field with a plant at Newcomerstown, Ohio. The plant size was doubled in 1959 and it is starting to outgrow that capacity.

Biggest plastics customer, the auto industry, is consuming its largest volume ever, Mr. Zimmerman reports. There are more than 300 plastic components in the 1961 cars, he says. "What's more important, there are approximately 22 lb. of plastic in the new car, replacing 150 lb. of metal."

It's inroads like these that spark Mr. Zimmerman's enthusiasm. "We're not only getting our foot in the door, we're becoming entrenched," he says. "This year you will see the transportation industry swing to heavy plastics fabrication of trucks, trailers and buses . . . you'll see the food industry lean heavily on packages of plastic . . . you'll see plastic plumbing replace metal pipes in new homes," he explains.

He is even more optimistic about prospects for his own plant, a producer of plastic sheeting for fabrication into end uses: "We look for at least a 30% increase in business in 1961."

### *Styrene copolymers*

Tyril 780, the second formulation of a planned series of styrene-acrylonitrile copolymers (first was Tyril 767), has been announced by The Dow Chemical Co. The new formulation is said to have optimum chemical resistance, heat resistance, and greater strength properties. The added latter two properties can be had in parts molded or extruded of the 780 material by using fabrication temperatures of some 20° F. higher than usual. Suggested applications include battery cases, oil and water filter bowls, fan blades, closures, etc. Tyril 767 is recommended for applications requiring high chemical resistance, but where extreme toughness is not a major factor. Both 780 and 767 are priced at 40½¢/lb. for natural when ordered in 80,000-lb. quantities.

**A new film-forming** styrene copolymer latex, to coat paper and paperboard for drinking cups, disposable containers, and food packages, has been introduced by Monsanto Chemical Co., Plastics Division. Designated Lytron 6A, the new material is said to provide a continuous, non-blocking, clear coating with excellent resistance to hot and cold liquids, and grease and oils. It is odorless, tasteless, and non-yellowing, the company claims, and is applied by spray, flush, or web coating with conventional equipment. It is available in 55-gal. drums and is priced at 23½¢/lb. in tank car lots.

### *New vinyl resin*

A vinyl chloride resin tailored for heavy gage sheeting, used in products ranging from baby pants to swimming pools, has been developed by the chemical division of The Goodyear Tire & Rubber Co. Called Pliovic BL-80, the new material is a blotter-type resin which can be pre-blended at room temperature and will absorb high amounts of plasticizers to form a relatively dry, free-flowing mixture without heating, the company claims. The new resin is produced at the Niagara Falls, N. Y. chemical plant and is available in 50-lb. bags and larger bulk units.

### *Lower-cost pipe resin*

A new high-density polyethylene resin developed specifically for use in sprinkler systems, potable water systems, farm water lines and for jet wells has been announced by Phillips Chemical Co., Bartlesville, Okla. Designated Marlex TR-*414*, the resin sells at a basic price of 36¢/lb., slightly less than other Phillips resins tailored for conduit and engineered pipe uses. Pipe made from the new resin is said to meet all requirements of Dept. of Commerce standard CS 197-60 for ASTM type III polyethylene, which uses a design hoop stress of 600 p.s.i., and National Sanitation Foundation requirements.

### *Flame resistant resins*

Production of two epoxy resins, made self-extinguishing through halogen (bromine) substitution on the epoxy molecule, have been announced by The Dow Chemical Co. The first is designated experimental resin X-3442. It is a semi-solid containing about 49% bromine and has utility in blends with conventional liquid epoxy resins. The second, named experimental resin X-3441.1, is a solid resin containing about 19% bromine and can be used either alone or in blends with conventional solid resins. A bromine content of 15 to 25% is said to make even clear castings self-extinguishing. Modulus properties are reduced at 300° F., but blends of

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**What is Lustran?** Lustran is a unique composition of styrene and other monomeric materials produced by using an entirely new concept of molecular arrangement. It employs an advanced polymerization technique to meet the higher requirements of more applications more efficiently than ever before. Whether your product requires components that run two hundred to the pound or ten pounds each, Lustran is the material for rugged performance and profit improvement.

**What are its properties?** Lustran is so versatile that it can be formulated to meet a broad range of physical, chemical and price requirements. Lustran has a unique combination of effective strength, rigidity, and other desirable properties to a significantly high degree. One Lustran formulation, for example, has 4 times the impact resistance of rubber modified styrene, 10 times that of general purpose styrene. Lustran has exceptional impact and tensile strength, a vast color range, rigidity, abrasion and chemical resistance as well as efficient, economical processability. Products made with Lustran have excellent surface appearance, hardness and gloss. You can drive nails or turn screws into Lustran. At zero degrees Fahrenheit, a 1/8 inch thick 24 inch square sheet withstands the shock of 25 foot pounds. Under an 800 pound load, an automotive armrest made of Lustran remains intact while the supporting metal screws fail.

**What are the uses for Lustran?** Lustran has been successfully injection molded into parts weighing as much as 3½ pounds and vacuum formed in deep drawn parts weighing up to 11 pounds. It will find great demand in products which require high impact strength, rigidity, and breakage resistance in addition to the traditional important advantages of plastics . . . built-in color, corrosion resistance, single-piece construction. Lustran promises new developments in design and cost savings for new products, components and housings for business machines, automobiles, refrigerators, air conditioners, fans, radios, television, vacuum cleaners and other appliances, housewares, shoes, packages, pipe fittings and toys. Wherever performance and cost are critical, Lustran will find application.

**What are its processing characteristics?** Plastics converters who have worked with Lustran have been astonished at the superior thermal stability of Lustran. Over a wide range of temperatures, it is possible to produce components with excellent uniformity in color and physical properties . . . performance not always achieved with other styrene polymers. With Lustran you can achieve consistent color control even in softest pastels. It can be molded and extruded in standard equipment. Sheets of Lustran can be formed, fabricated, and decorated using conventional techniques.

**Can you capitalize on this development now?** Lustran is now available from interim production facilities which can meet anticipated commercial requirements. A fifty million pound plant is now under construction. It will be in operation the latter part of 1961. With the addition of the Lustran family of plastics to our familiar Lustrex styrene molding materials, Monsanto now supplies the broadest spectrum of styrene based materials.

An extensive program has been set up to acquaint plastics converters with the unique capabilities and business building opportunities of Lustran. Plastics converters are invited to contact the nearest Monsanto sales office for more information. Designers and manufacturers are invited to write for current data and progress reports to Monsanto Chemical Company, Plastics Division, Dept. 803, Springfield 2, Massachusetts.

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*(From page 212)*

self-extinguishing epoxy with Dow's epoxy novolac resin are expected by the company to result in higher modulus at elevated temperatures. Initial prices range from $1.25 to $2.01/lb. for X-3442 and from $1.00 to $1.76/lb. for X-3441.1.

**A new flame-retardant** fibrous glass-reinforced polyester molding compound is being offered to molders of electrical insulating parts by The Glastic Corp., Cleveland, Ohio. Designated Grade 1506, the premix is said to have high impact strength, dimensional stability, low water absorption, and is claimed to be usable in most existing molds.

### Coating resin commercial

The new National Starch & Chemical Corp.'s 14-million-lb. vinylidene chloride plant at Meredosia, Ill., whose construction was announced last summer, is now in production. The product, an aqueous dispersion of vinylidene chloride copolymer, will be known as Resyn 3600.

Because of its low water vapor transmission rate and excellent barrier resistance to vapors and gases, as well as to chemicals, grease, and oil resistance, it is expected to become particularly useful as a coating for packaging materials. It is suggested as a coating for multiwall sacks, fiber drums, paper boxes, shipping cartons, paper pouches, and food containers, and also as a textile saturant, a binder for nonwoven fabrics, and as a finish for industrial as well as work clothing fabrics.

### New European polypropylene

Imperial Chemical Industries Ltd., Millbank, London, England, has started production of its own brand of polypropylene at its Wilton Works in Yorkshire. Designated Propathane, the resin is said to have a density of 0.900, making it the lightest commercial plastic to date. ICI polymerizes propylene under low pressures and at normal temperatures using Ziegler type catalysts. The product is predominantly isotactic in form. Capacity of the facility is about 25 million lb./year. Prior to ICI's entry into this field, Europe's polypropylene production was primarily in the hands of Montecatini in Italy.

### Mold releases

Two new products have been added by Chem-Trend, Brighton, Mich., to its line of mold release agents. Poro-Coat, a practically colorless and odorless fluid dispersion of waxes and resins, which contains no silicones and is said not to separate on standing, is specifically designed for release of flexible one-shot polyurethane foam. Mono-Coat, a white fluid dispersion with good mold-wetting qualities, and said to require no curing or multiple application, is designed for release of polyester and epoxy. Both are applicable by spray or brush.

**A fluorocarbon mold** release agent in 6-oz. aerosol spray cans has been introduced by Dixon Corp., Bristol, R. I. Called Rulon Spray, it is claimed to be chemically inert, insoluble, and thermally stable to over 500° F., and can be used where painting, plating, as well as hot stamping, follow the molding operation.

### Fungus resistant plasticizer

An epoxy plasticizer-stabilizer that can reportedly make vinyl films fungus-resistant has been introduced by Union Carbide Chemicals Co. Designated Flexol PEP, Carbide expects the new plasticizer to increase the utility of vinyl resins for pond liners, floor tile, shower curtains, building covers, etc. Known chemically as di(iso-decyl) 4,5-epoxy tetrahydrophthalate, it is priced at 40¢/lb., delivered in tank car lots.

### New colors

Eight new fluorescent color lines for screen-process printing on a variety of materials including soft and rigid vinyls, polystyrene, acrylics, polyester film, textiles, etc., have been formulated by Advance Process Supply Co., Chicago, Ill. They are sold under the tradenames Lumi-Glo and Strike.

**A new quinacridone pigment** with a brilliant red-violet hue, designated Quinda Magenta RV-6803, is now available from Harmon Colors, Allied Chemical's National Aniline Div., for use in plastics, printing inks, and industrial finishes.

### Ultra-violet light absorber

Tinuvin P, a benzotriazole derivative, soluble in organic solvents, has been developed as a UV absorber and stabilizer by J. R. Geigy S.A., Basle, Switzerland. The new compound is said to have been used effectively in polyester resins, vinyls, polystyrene, acrylics, and experimentally in polyethylene. It is available in the U. S. from Geigy Industrial Chemicals, Ardsley, N.Y.

### Diphenolic acid

An intensive sales campaign for a new chemical intermediate called Diphenolic Acid developed by researchers at Johnson's Wax Corp. of Racine, Wis., is now under way. Among the possibilities for use in plastics are polyether acids for modification of polyester isocyanate to give a wide range of rigid to solid foam. It is also said to be highly compatible with the bisphenol-epichlorohydrin type of polyepoxides and thus capable of providing specific properties such as internal plasticization and water solubility.

In the field of resin additives or modifiers, the acid offers opportunity to accomplish two objectives with the same molecule. For example, the metal salts are being evaluated as stabilizers exhibiting at the same time the cidal properties inherent in phenolic structures.

The company has formed a task group under Dr. Robert V. Smith to work with potential consumers and consult with them on possible applications.

### For metallizing coats

An epoxy ester, single-package system for vacuum-metallizing finish-coating application, that may be used as both the base-coat and top-coat, has been introduced by Sullivan Chemicals Div., Sullivan Varnish Co., Chicago, Ill. Designated CL-6091 Epoxy Metalplex, the coating, according to the company, produces a hard and mar-resistant film that also resists soap and detergents, grease, staining, water immersion, alcohol, and salt air, and has a shelf life of one year.

Although CL-6091 may be

*(From page 215)*

sprayed as supplied, additional solvents such as mineral spirits or V M & P naphtha may be added to make it suitable for flow-coating or dipping operations when adjusted to the desired viscosity, the company claims. After base-coating, a flash-off time of 15 min. and cure for one hour at 155° ± 5° F. is required. Finished parts should remain at room temperature for 96 hr. before being subjected to any test procedures. Single 55-gal. drum is priced at $3.80/gal.; lots of 10 drums or more are priced at $3.60 per gallon.

### Intermediate for epoxies and urethanes

Antara Chemicals Div., General Aniline & Film Corp., New York, N. Y., has announced commercial availability of butenediol in two grades, technical and purified. Among current applications are use as a chemical intermediate for polyurethanes and epoxies. Prices, in tank car lots, are 73¢/lb. for technical grade and 90¢/lb. for purified grade.

### Enters foam packaging field

Formation of a new division that will produce, design, and mold polystyrene foam for packaging has been announced by General Box Co., Des Plaines, Ill. Charles E. Keene, former manager of the company's wirebound and corrugated plants in Meridian, Miss., will manage the new division. Harold F. Shroyer, formerly president of Insta-Mold Plastics Inc., Stonington, Conn., is superintendent.

### Latest breathable vinyl

What is claimed to be the most "breathable" fully vinyl-coated fabric material yet put on the market has been developed by the Textile Div. of Knoll Associates Inc. Named Brigadoon, the new line is printed and embossed to simulate a linen tweed. The vinyl formulation was designed exclusively for Knoll by the Fabrics Div. of E. I. du Pont de Nemours & Co.

Greater breathability is attained through what is claimed to be a new perforation process which allows air circulation through thousands of invisible pores, dissipating heat and vapor and resulting in a cooler, more comfortable material. However, no details on the process have been revealed.

### To make fluorocarbon plastics bondable

Redel Inc., Anaheim, Calif., has announced expanded capacity for custom etching of Teflon, Kel-F, and other fluorocarbon plastics to make them bondable. The company states that the service is offered through a licensing arrangement with Minnesota Mining and Mfg. Co. for patent No. 2,789,063 covering etching of fluorocarbon materials (except pressure sensitive tapes). Colorless and conventional etched surfaces are offered.

### Flocked Mylar

Development of rayon flocking for Mylar film has been announced by Cellusuede Products Inc., Rockford, Ill. The film used is 1.5-mil thick and the flocking adds 0.030 inch. According to the company, the finished product has a velvet-like appearance with good strength and durability. Flocked Mylar, produced in a wide range of colors, is available in 50-yd. rolls, 36-in. wide. Other thicknesses of Mylar are available on request.

### Polypropylene tubing

A new polypropylene tubing manufactured by Imperial-Eastman Corp., Chicago, Ill., and tradenamed Impolene, can reportedly be used at operating temperatures up to 300° F. and working pressures to 450 p.s.i. The tubing is claimed to have 30 to 50 times the life of nylon at elevated temperatures and can be repeatedly steam sterilized, according to the company. Other advantages claimed are dimensional stability, corrosion and abrasion resistance, and high tensile strength. Suggested applications are for use in automobiles, lubrication systems, pumps, etc.

Impolene tubing is supplied in 0.023-, 0.034-, 0.040-, and 0.062-in. wall thicknesses and ⅛- to ⅜-in. O.D. sizes; ⅛-in. tubing is furnished in 1000-ft. spools, other sizes in 500-ft. spools, natural or black. Price will depend on quantity for production run.

### New ACS group

A Polymer Chemistry Group to establish educational programs and promote polymer chemistry in all aspects has been formed as an affiliate of the Southeastern Section of the American Chemical Society. The new group has 61 charter members representing 27 Gulf Coast companies. G. W. Daues, Monsanto Chemical Co., Texas City, Texas, is chairman. Membership in the new group is open to all members of the American Chemical Society.

### Standards for testing prepregs

Three official industry standards on test methods for determining resin and volatile content, flow, and gel time of preimpregnated materials for reinforced plastics and high-pressure laminating have been developed by the Pre-Preg Div. of The Society of the Plastics Industry Inc. Copies may be obtained by writing the S.P.I., 250 Park Ave., New York 17, N. Y.

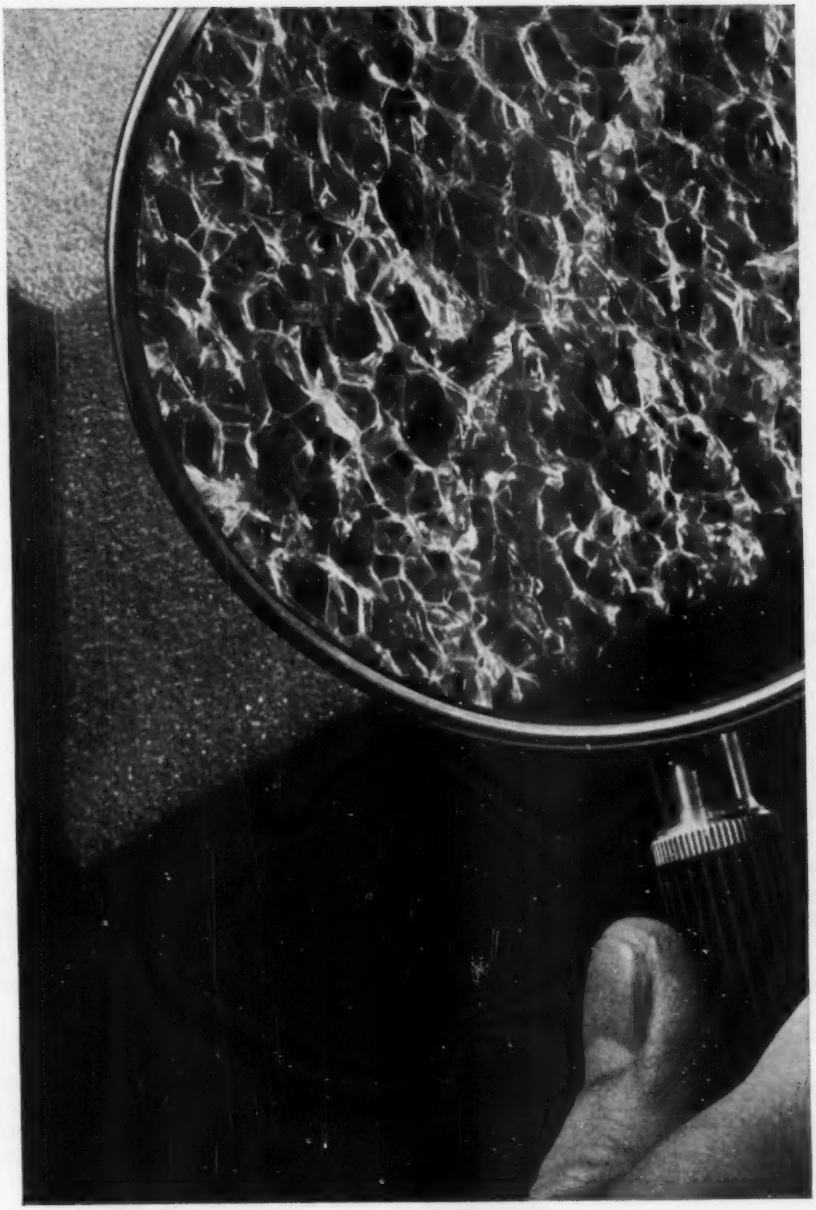
### Large nylon plate

Nylon plate measuring 2 by 4 ft. and ranging in thicknesses from ½ to 4 in. is now available from The Polymer Corp., Reading, Pa. The plate is made of MC Nylon, a proprietary formulation, and prices are claimed by the company to average 15% below plate of types 6/6 and 6 nylon. The new MC plate sizes are expected to expand application for nylon in such uses as wear plates, bumper pads, and fixtures. Tubular bar and rod up to 17-in. O.D. and MC Nylon plates larger than 2 by 4 ft. can be supplied on special order.

### Polypropylene for rope

Between 750,000 and 800,000 lb. of polypropylene were used for rope in its first full year of production, according to Robert D. Bartlett Jr. of Dawbarn Bros. Inc., who stated that this compares with 3,800,000 lb. of nylon and 500,000 lb. of Dacron. But because of its 0.90 specific gravity, it gives 26.7 and

# THERE'S ONLY ONE STYROFOAM®



**Styrofoam is Dow's registered trademark for its expanded polystyrene—Only Dow makes Styrofoam expanded polystyrene**

Styrofoam is applied only to the homogeneous expanded polystyrene made according to an exclusive Dow manufacturing process that gives the material its unique physical properties.

Styrofoam is always spelled with a capital "S" because it's a trademark. It's *not* the name of a general class or type of material! And it does *not* refer to other foamed polystyrenes made by different processes.

"Styrofoam" identifies Dow's expanded polystyrene. For superior insulation and flotation applications be sure you specify and get Styrofoam brand. Styrofoam is exclusive with Dow—there is no such thing as a "substitute"!

**For Expandable Beads, Ask Dow, too.**

When you want an expandable bead material for packaging, display or other purposes, ask Dow. We make Pelaspan® expandable polystyrene beads for molding shock-resistant, form-fitting packages and hundreds of other uses. In fact, Dow supplies molding plastics for every modern need.

**THE DOW CHEMICAL COMPANY** DOW Midland, Michigan

## THE PLASTISCOPE

*(From page 216)*

53.3% greater yield than nylon and Dacron. Thus, in terms of linear footage, it gave more than twice as many feet as was produced from the other synthetics.

Mr. Bartlett said the reasons for polypropylene's success were less water absorption, which affects strength; elongation; storability; knotability; and low cost—the cheapest of all synthetics; outlasts manila two to three times; wide variety of colors.

### *New companies*

**Airpak Inc.,** 1 Erie St., Paterson, N. J., has been formed by **W. C. Leipold** and **Maurice Brown,** former president and secretary-treasurer of Plastic Horizons Inc., for the manufacture of various plastics packaging materials. **P. Bernard Nortman** is marketing director. Messrs. Leipold and Brown jointly established Plastic Horizons in 1953. The company was recently purchased by Celanese Corp.

**Aard Plastics Inc.,** 169-175 Linwood Ave., Paterson, N. J., is a newly established company engaged in the extrusion of thermoplastic materials. **Herb J. Weber** is president and general manager, **Henry Barbour** is plant superintendent.

**Stauffer-Hewitt Inc.** has been formed by **Stauffer Chemical Co.** and **Hewitt-Robins Inc.,** for the manufacture of polyurethane foam materials. The new company will purchase the assets of Hewitt-Robins' Urethane Foam Div., Franklin, N. J., including the tradename Restfoam. Stauffer owns two-thirds of the company.

**Thomas Engineering Co.,** Madison, N. J., has been formed by **Islyn Thomas,** who has resigned as president of **Newark Die Co.** Mr. Thomas is well known as author of the original book "Injection Molding of Plastics" and of many technical and engineering articles on plastics. The new organization will furnish consultant service to the plastics industries all over the world. Mr. Thomas is past-president and life member of the **Society**

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of **Plastics Engineers,** has been a board member of **The Society of the Plastics Industry,** is a member of the Plastics Pioneers as well as of the **Plastics Institute** in London, England.

### *Expansion*

**National Vulcanized Fibre Co.** has acquired the **Fisher Mfg. Co. Inc.,** Hartwell, Ga. supplier of metal, vulcanized fibre, reinforced plastics, and fibre-armored materials-handling receptacles for the Southern textile industry. Fisher is located approximately 50 miles southeast of Greenville, S. C.

The Georgia firm is the second acquisition announced by National Fibre within the past year and a half. In 1959 National acquired Parsons Paper Co., Holyoke, Mass. manufacturer of cotton fiber business papers.

In addition to these two, National Fibre now operates plants at Wilmington, Newark, and Yorklyn, Del.; Kennett Square, Pa.; Johnson City, N. Y.; Chicago, Ill.; Los Angeles, Calif., and a subsidiary in Toronto, Canada.

National Fibre sales in 1960 were close to the $24 million posted in 1959. The company expects volume to be $32 million in 1964.

**Eldon Industries Inc.,** Hawthorne, Calif., has purchased the fixed assets and inventory of **Knickerbocker Plastics Div.,** North Hollywood, Calif. subsidiary of **Knickerbocker Toy Co.,** New York, N. Y. A new corporation, **Eldon/Knickerbocker,** has been formed, which will operate as a wholly-owned toy manufacturing subsidiary of Eldon Industries Inc.

**Lasco Industries Inc.,** Montebello, Calif. manufacturer of plastic pipe and translucent building panels, has announced it will diversify into chemical production through the **Borane Chemical Corp.,** a newly-formed subsidiary. The new company, which is 51% owned by Lasco, has constructed a 5000-sq.-ft. research laboratory and plant, on Lasco's 4½-acre site, capable

of producing polyesters, monomers and prepolymers, all condensation products, catalysts and chemical intermediates in one unit.

**Michael N. Gilano** and **Irvin W. Martenson,** co-founders of the company with Lasco, will serve Borane as president and vice-president, respectively.

**Burton-Dixie Corp.,** Chicago, Ill., is constructing a 50,000-sq.-ft. plant in Blacksburg, S. C. for the manufacture of polyether-urethane foam for the upholstered furniture and bedding trades. The new plant will have a capacity of 120 lb. of foam per minute, and its output will be marketed under the tradename Dixiefoam. Prior to its entry into the urethane-foam industry, the company was a manufacturer of bedding products, which activity it will continue.

**Aziende Colori Nazionali Affini (ACNA),** Cenigo, Italy, a subsidiary of the **Montecatini** group, has completed a 22-million-lb/yr. phthalic anhydride plant. The new facility is said to be the largest phthalic anhydride plant in Italy, and the first to employ a fluid-bed catalytic process. The process is licensed exclusively by **Badger Mfg. Co.** (which designed the plant) under an arrangement with **The Sherwin-Williams Co.**

**Northwest Plastics Inc.** has completed a 10,000-sq.-ft. addition to its Belle Plaine, Minn. plant, which will enable the company to enter the compression molding industry. The firm had previously been only active in injection molding. The Belle Plaine plant will be operated by **Excelsior Plastics,** a wholly-owned subsidiary of Northwest.

**The Borden Co.** and **U. S. Rubber Co.** have jointly acquired about 850 acres of land near Geismar, La., for the construction of a $50-million complex of chemical plants. The joint venture will be known as **Monochem Inc.** The Monochem facilities will have an initial capacity of more than 80 million lb. of acetylene and approximately 150 million lb. of vinyl chloride monomer yearly. Borden and U. S. Rubber will erect individually-owned plants adjacent to the Monochem operation. These plants will use

## THE PLASTISCOPE

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Monochem's output in the manufacture of a variety of chemical products. Completion of the Monochem facilities is scheduled for sometime in 1962.

**Ferro Corp.**, Cleveland, Ohio, has completed a $250,000 facility in North Miami, Fla., for the production of fibrous glass reinforcements and colorants for plastics. **J. Gerry Browne** was named manager of the new 15,000-sq.-ft. installation; **Leonard J. Tanski** will supervise the colorant section.

**Milprint Inc.**, flexible packaging materials producer has dedicated a new 57,000-sq.-ft. plant at South San Francisco, Calif. This brings production and office space to almost 100,000 sq. ft. and consolidates the company's operation on its 5-acre site in South San Francisco. Over 200 people will be employed in the plant and office. Milprint now has four plants in the U. S., and has associated companies in 23 foreign countries. Over 3000 people are employed by the firm, a subsidiary of **Philip Morris Inc.**

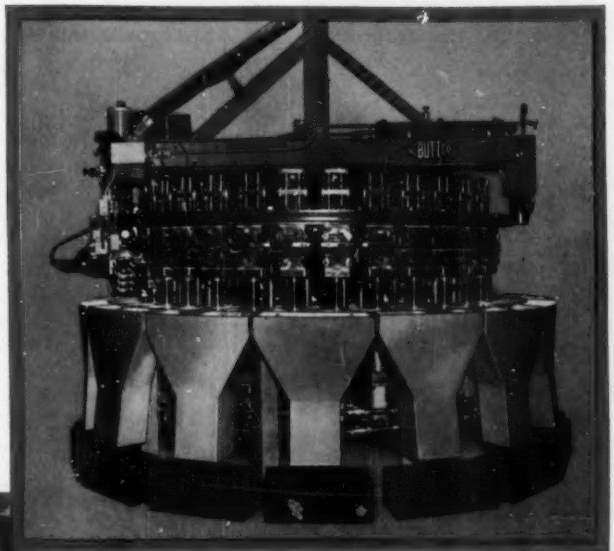
**Thatcher Glass Mfg. Co.** has announced a $1.2-million expansion program of its Muscatine, Iowa plant to increase production of its Celon closure division and plastic squeeze tube division. The new facilities, which represent an increase in plant space of more than 25%, are expected to be completed about June 1961. **Dr. Kenneth E. Glidden** will be in charge of production at the enlarged facilities.

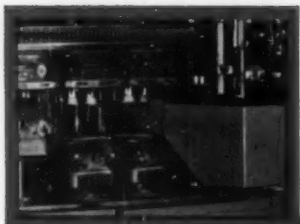
**Dow Hellenic Chemical Industry Ltd.**, a new Dow subsidiary, is constructing a polystyrene plant at Lavrion, Greece, a suburb of Athens. Completion is scheduled for late November 1961. **Raymond Duddleston** is project manager for the new unit, with responsibility for supervision of engineering, construction, and starting operations.

**Ray Products Inc.**, Alhambra, Calif. vacuum former, has acquired a 7500-sq.-ft. building adjacent to its present plant which will house a

# 6,000 PIECES PER HOUR

**This NEBUTTCO Automatic Rotary Press Molds Thermosetting Closures FAST**





Molds are progressively opened, charged with compound, and closed under pressure for curing as feeding arm revolves around machine.

Cam-actuated rotating wheel automatically unscrews closures as molding cycle is completed.

NEBUTTCO

The thirty stations on this Nebuttco Rotary Press provide high speed, continuous molding of large or small quantities using any free-flowing thermosetting compound in low cost, single or double cavity molds. Providing the closures are the same color and similar in section, as many as three different molds can be used in the machine at one time.

The compound is hopper-fed, and precision metered through the rotating feeder arm. Machine eliminates sorting problems, because stations eject parts into separate metal chutes. Production cycle can be varied and the temperature in the mold holders can be individually adjusted if required.

The machine is available in one model — the thirty-station press illustrated. This machine is easy to install and maintain, and is adaptable for many applications.

For more information please contact

**NEW ENGLAND BUTT COMPANY**

Division of Wanskuck Co.

**304 Pearl Street, Providence 7, Rhode Island**

## THE PLASTISCOPE

*(From page 222)*

new four-ram, air-operated forming press, and a 12- by 12- by 10-ft. forming oven.

**The Black-Clawson Co.,** manufacturer of plastics converting machinery, and pulp and paper mill equipment, has acquired the plastic extruder business of **Aetna-Standard Div. of Blaw-Knox Co.,** Pittsburgh, Pa. Engineering, manufacture, and sales of Aetna-Standard extruders will be conducted by the newly formed **Hale & Kullgren Plastics Dept. of Black-Clawson's Dilts Div.** under division general manager, **Richard W. Phelps.** Hale & Kullgren plan to manufacture the equipment in its Hamilton, Ohio facilities.

**The Heisler Corp.,** Wilmington, Del., has recently established a plastic and elastomer-compounding and powdered-resin development laboratory, and is opening a second plant in Wilmington as part of an over-all expansion program. The new facilities will include 60,000 sq. ft. of warehouse space and new compounding equipment.

**Polymer Industries Inc.,** adhesives and textile polymer specialties subsidiary of **Philip Morris Inc.,** has completed a million-dollar expansion program in Springdale, Conn. in the past year. The program included construction of two new plants; one for resin polymerization and the other for solvent products manufacture.

**Pittsburgh Plate Glass International S.A.,** Geneva, Switzerland, and **Algemene Kunstzijde Unie N.V.,** Arnhem, Holland, have announced plans to form a jointly-owned fiber glass company in the Netherlands at a location to be disclosed later. The plant will initially employ 150 persons. Operations are expected to start in 1962.

**Majestic Molded Products Inc.** has expanded its injection and blow-molding divisions in a move to a new 100,000-sq.-ft. plant located at Majestic Park, Holbrook, L. I., N. Y. **Henry Wish** is president and

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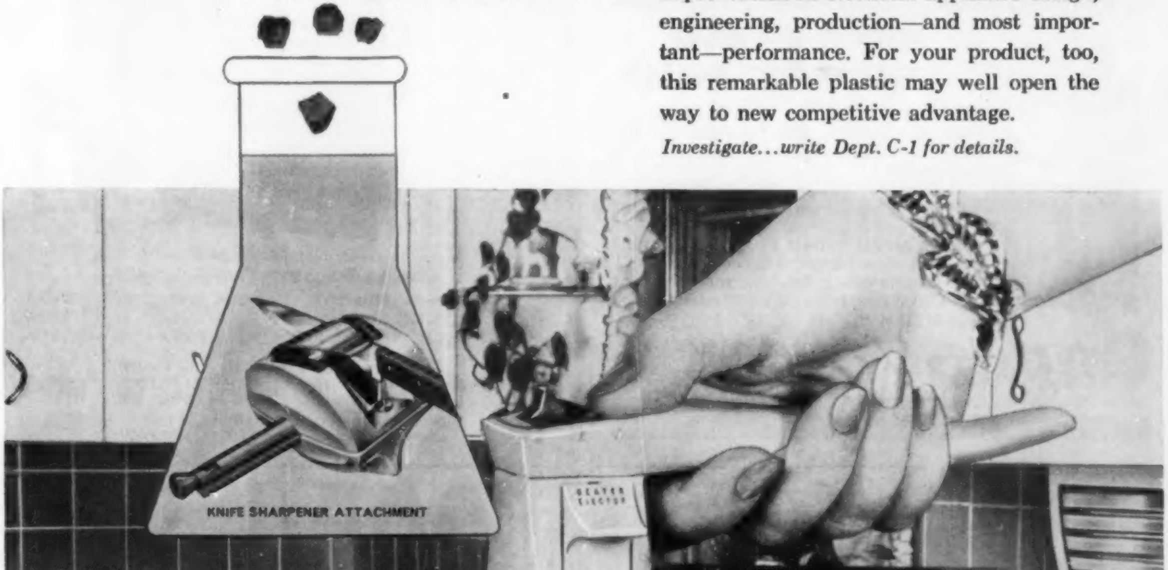
This smartly styled General Electric Portable Mixer had to have a housing with complete dimensional stability, had to ignore food and juice stains, resist kitchen marring and scarring—yet be light enough to keep the mixer's weight at only 2¾ lbs. That's why G.E. engineers specified CYCOLAC—the ABS plastic from Borg-Warner—for both housing and handle. The unique balance of properties offered by CYCOLAC provides ever-increasing opportunities for outstanding improvement in electrical appliance design, engineering, production—and most important—performance. For your product, too, this remarkable plastic may well open the way to new competitive advantage.

*Investigate... write Dept. C-1 for details.*




**MARBON CHEMICAL** DIVISION **BORG-WARNER**
WASHINGTON WEST VIRGINIA

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(From page 224)

**Norman R. Davis** serves as executive vice-president.

**The Nalge Co. Inc.,** Rochester, N. Y., has added an extension to its plant which will increase existing production and warehouse space of plastic laboratory bottles by about 25 percent.

**E. I. du Pont de Nemours & Co.** and **Mitsui Petrochemical Industries Ltd.,** of Tokyo, have announced plans to form a jointly-owned Japanese company for the manufacture of high-density polyethylene. The new company, to be known as **Mitsui Polychemicals Co. Ltd.,** has been approved by the Japanese government. It will be capitalized at $18 million. Production facilities will be built on an existing site owned by Mitsui Petrochemical in Otake, Hiroshima Prefecture, with operation expected to start in 1962.

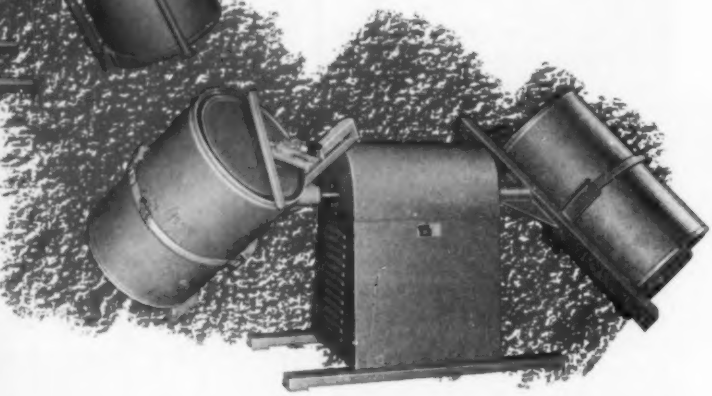
**The Polymer Corp.,** Reading, Pa., has established a wholly-owned subsidiary in Cologne, West Germany. The new organization, known as **Polypenco G.m.b.H.,** will stock and distribute nylon, Teflon, and other semi-finished shapes of industrial plastics that are produced by The Polymer Corp.

**Interchemical Corp.** has purchased the business and assets of **The Landers Corp.,** Toledo, Ohio manufacturer of plastic-coated fabrics. The Landers plant, which has a staff of about 175 people, will operate as a unit of the newly-formed **Coated Fabrics Div.** of Interchemical and will continue to manufacture its present line of products.

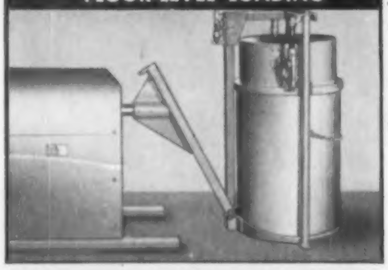
**U. S. Rubber Co.** and **Rumianca, S.p.A.,** Torino, Italy, have signed a technical service agreement for production of polyvinyl chloride resins at a plant to be built by Rumianca at Pieve Vergonte, Italy. The plant is expected to cost about $3 million, and is scheduled to go into production by mid-1962. U. S. Rubber, through its Naugatuck Div., will furnish technical information and engineering services for

# "U.S." *HEAVY-DUTY* DRUM TUMBLERS

## *for Faster, Easier Dry Color Mixing and Compounding*



FLOOR-LEVEL LOADING



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QUICK-ACTING TOGGLE CLAMPS

ADJUSTABLE DRUM HOLDERS

17-G

You can save time . . . cut costs . . . speed production by tumble mixing colorants and molding materials right in their shipping drums. "U. S." Drum Tumblers are designed to do the job quicker, easier, more effectively.

These precision-built machines have sturdy welded construction for long life and trouble-free service. Their rugged steel bases provide rigid support for handling unbalanced loads. Positive roller chain drives, extra powerful motors and heavy-duty ball bearings assure smooth tumbling action under heavy loads.

Only "U. S." Drum Tumblers offer such extra ease of operation. Custom-built to meet specific mixing requirements, they are available with typical features shown at left — "floor-level" loading for quicker, easier drum handling; built-in drum extenders, providing extra space for thorough mixing of full drum loads; quick-acting toggle clamps for rapid opening or closing in one easy motion; adjustable drum holders to handle various size drums.

"U. S." Drum Tumblers are built in a range of sizes to handle standard fiber or metal drums; with motors of ¾, 1, 2, 3, and 5 h.p.; capacities from 250 to 500 lbs. per drum. Our Engineering Service Department will gladly recommend the proper unit to meet your specific mixing requirements. Write today for complete details.

*PROCESS EQUIPMENT DIVISION*

**U. S. STONEWARE**
AKRON 9, OHIO

## THE PLASTISCOPE

*(From page 227)*

design of the plant and its initial operation. The agreement also provides for patent licenses to the Rumianca firm for manufacture and sales of the vinyl resins in Italy, and for use and sale of the plastics products in other parts of the world.

**Witco Chemical Co**. has completed a $250,000 expansion of its Chicago, Ill. laboratories for research and development on polyester and polyether resins for urethane foams and solid-cast elastomers.

**The Emeloid Co., Inc.,** Hillside, N. J., has consolidated with **Addressograph-Multigraph Corp.,** Cleveland, Ohio, through an exchange of shares, according to a joint announcement. The Emeloid Co., manufacturer of injection-molded, vacuum-formed, and die-cut plastic components and laminated-sheet plastics items such as customer credit cards, will operate as a subsidiary of Addressograph-Multigraph, manufacturer and distributor of business machines.

**Owens-Corning Fiberglas Corp.** has acquired a substantial minority interest in **Fibreglass South Africa (Pty.) Ltd.,** producer of thermal insulation products. The other shareowners are **Plate Glass & Shatterprufe Industries,** South African manufacturer in the flat glass field, and **Fiberglass Ltd.,** manufacturer of glass fiber products in Great Britain. Plans are in progress for establishment of a new production facility at the company's principal location at Springs, Transvaal, to manufacture glass fiber products for the electrical and reinforced plastics industries.

**Lamtex Industries Inc.,** Farmingdale, N. Y. manufacturer of reinforced plastic structures, has acquired 14,000 sq. ft. of additional plant space adjoining its present location and has added several pieces of new equipment, including a 750-ton hydraulic press.

***Deceased***

**George H. Clark,** 70, retired vice-president, manufacturing, of **Formica Corp.,** died in Cincinnati, O. on Dec. 30. He was born in South Paris, Maine, and graduated from M.I.T., Boston, in 1913. Mr. Clark joined Formica in 1926 and held many positions. As vice-president he was in charge of building and supervision of plant facilities. He served as director of the Society of Plastics Industries from 1944 to 1951, as president from 1947 to 1949, and as chairman from 1949 to 1951. Mr. Clark retired from Formica in 1956, but had remained with the company on a consultantship basis. Surviving are his wife, a son, and two grandchildren.

**Henry D. Randall** died Dec. 7 at his home in Annapolis, Md. He formed the original Plastics Dept. in **General Electric Co.,** and after retiring from GE at the age of 65

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in 1946, served as sales manager and technical consultant for **Insulating Fabricators** until 1959.

**Hylton Swan,** 86, retired vice-president of **Bakelite Corp.,** now **Union Carbide Plastics Co.,** died Dec. 16 at Pine Acres in Madison, N. J., after a long illness.

**Benjamin H. Davis,** founder of **Davis-Standard Corp.,** Mystic, Conn., sole sales agent for **Standard Machinery Corp.,** died suddenly at his home in November. He was vice-president in charge of engineering and sales for Standard Machinery, and vice-president and director of the parent organization, **Franklin Research & Development Corp.,** Boston, Mass.

**Leroy T. (Doc) Barnette** died Dec. 19, following a heart attack. He had retired from **Hercules Powder Co. Inc.** in 1957 where he had been manager of Plastics Markets in the Cellulose Products Dept. He joined Hercules in 1942 after serving as editor of MODERN PLASTICS; had also served with OPM in Washington, D. C., and was previously president of H. A. Husted Co., Akron, Ohio, and plant manager of Standard Products, Detroit, Mich.

**Thomas B. Blevins Jr.,** 39, Deputy Chief of the Materials Section, Research Branch, **Office of the Chief of Ordnance,** was struck and killed

instantly by a car in front of his home about noon on Jan. 7. He was in charge of plastics and rubber research for the Army Ordnance Corps since 1951, and was the liaison member for the Ordnance Corps in the Society of the Plastics Industry. In that capacity Mr. Blevins was a member of the Policy Committee of the Reinforced Plastics Division of S.P.I., was responsible for the establishment of military specifications in plastics, and was the force behind the establishment of the plastics information facility for the Defense Establishment at Picatinny Arsenal. He operated amateur radio station W4UMF in the basement of his home, and was well known in "ham" circles. He was a member of the Military Amateur Radio System (MARS) Network. He is survived by his wife, Mary Ann, and three children, Diane, 17; Sharon, 13; and Terrence, 4 months.

### *Meetings*

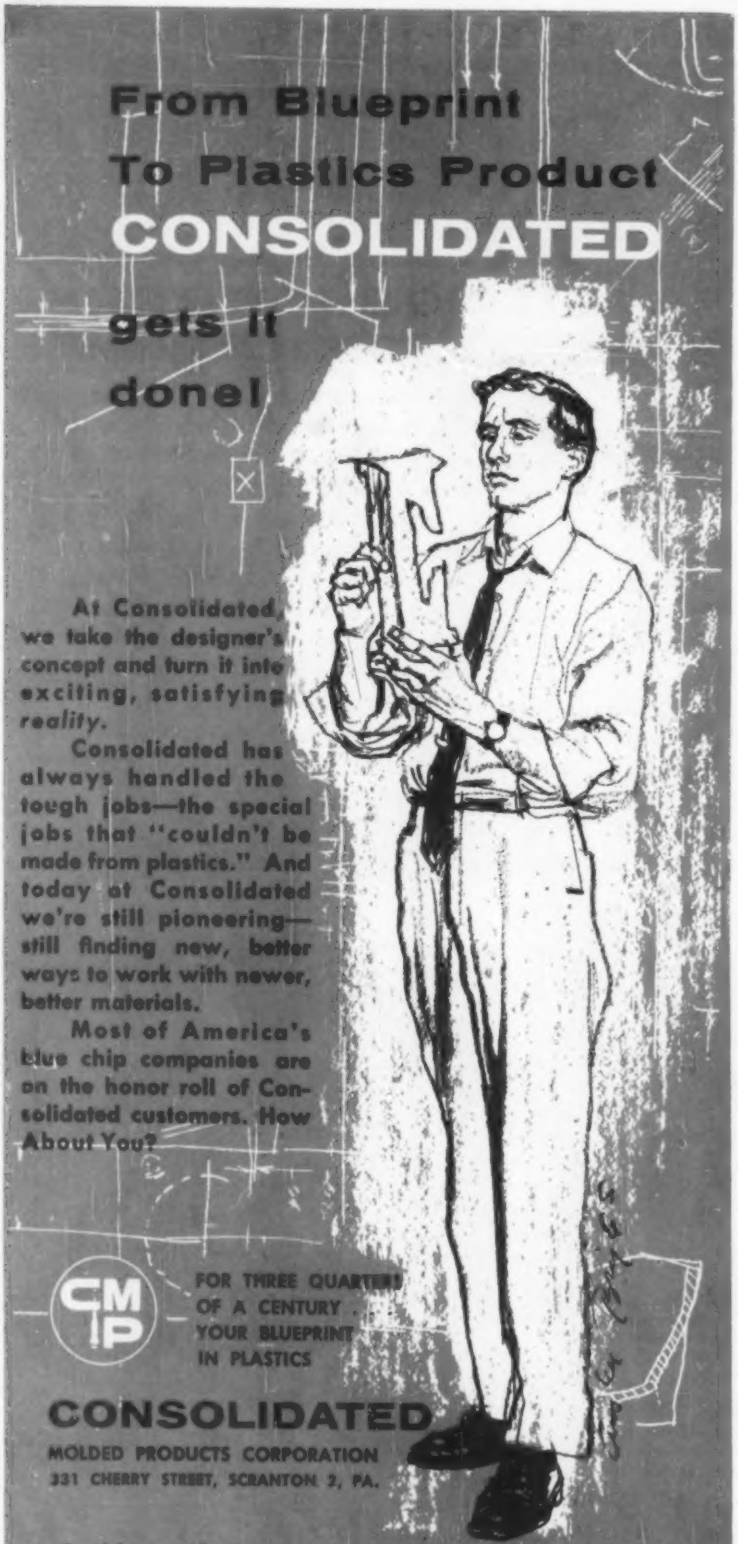
**Plastics groups**

**April 12-14:** Deutsche Kunststoff-Tagung, Berlin, Germany.

**April 20, 21:** The Society of the Plastics Industry (S.P.I.), 18th Annual Western Section Conference, Hotel del Coronado, Coronado, Calif.

**June 5-9:** S.P.I. 9th National Plastics Exposition and National Plastics Conference, Coliseum and Commodore Hotel, New York, N. Y.

**June 9-17:** European Congress of Chemical Engineering ACHEMA

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Congress and Exhibition, Frankfurt am Main, Germany. Simultaneously, and in the same city, 15th Meeting of European Federation of Corrosion.

**June 16-25:** Europlastica 1961, Palais des Floralies—Parc, Ghent, Belgium. For additional information, write: H. P. Persin, Sec. General, at above address.

**June 21-July 1:** Interplas 61, 6th International Plastics Exhibition and Convention, Olympia, London, England.

**July 27-Aug. 1:** International Symposium on Macromolecular Chemistry, Queen Elizabeth Hotel, Montreal, Canada.

### Other groups

**Feb. 20-23:** Technical Assn. of the Pulp & Paper Industry (TAPPI) 46th Annual Meeting, Hotel Commodore, New York, N. Y.

**Feb. 26-Mar 1:** American Institute of Chemical Engineering, 1st A.I.Ch.E. Petrochemical and Refining Exposition, Municipal Auditorium, New Orleans, La.

**Mar. 3:** Akron Polymer Lecture Group, "Thermal Decomposition of Unsaturated Materials," Knight Hall, University of Akron, Akron, Ohio.

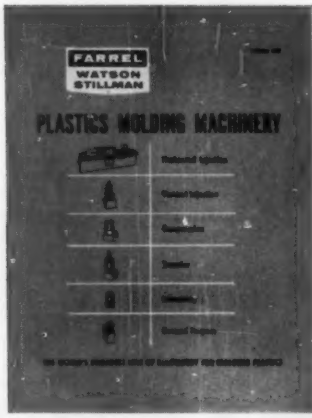
**Mar. 7:** TAPPI program, "The Development of Plastics as a Packaging Medium," Chicago Bar Assn., Chicago, Ill.

**Mar. 27-31:** 3rd National Symposium on "Temperature—Its Measurement and Control in Science and Industry," jointly sponsored by American Institute of Physics, Instrument Society of America, and National Bureau of Standards, will be held in Columbus, Ohio.

**Mar. 28:** Rochester Society for Quality Control 17th Annual Quality Control Clinic, University of Rochester, Rochester, N. Y.

**Apr. 10-13:** AMA National Packaging Show, Exposition Center, Chicago, Ill.

**June 20-29:** IPACK Biennial International Packing and Packaging Exhibition, Milan, Italy.—**End**

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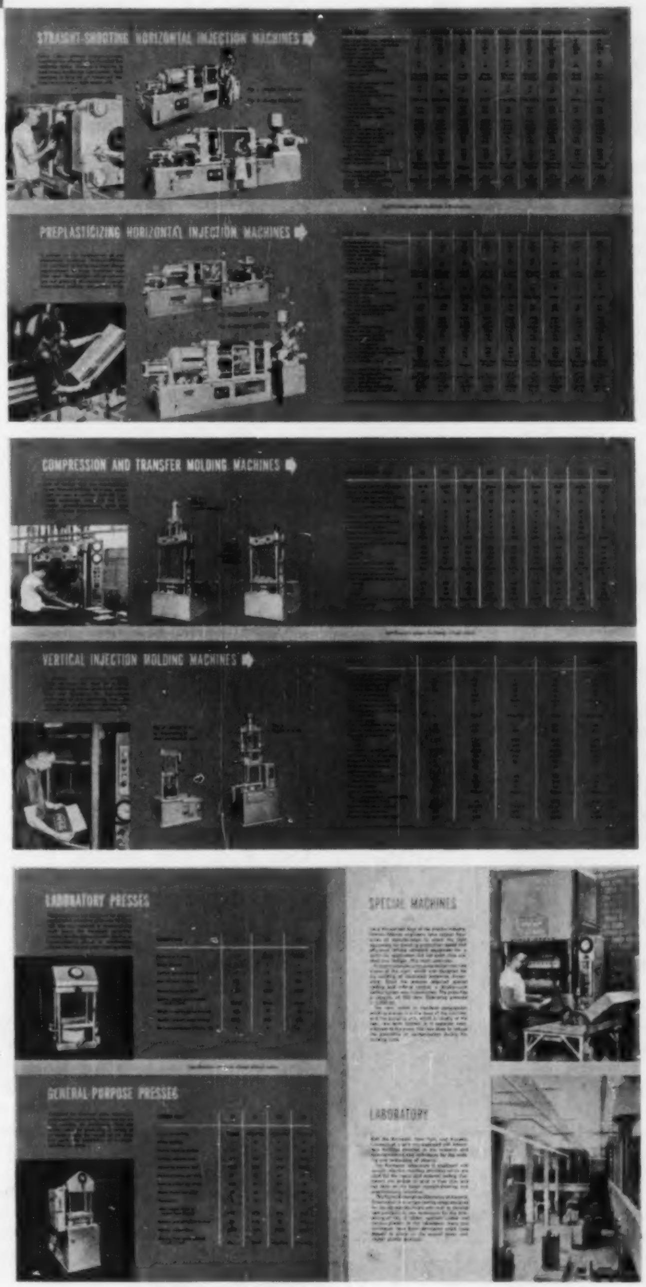


This handy new bulletin contains more information on what is available in plastics molding machinery than has ever before been published in one manual. It is, in short, a buyers' guide, which contains the necessary data for the intelligent selection of equipment.

Here you will find tables giving specifications for all the types of molding machines manufactured by Watson-Stillman. Included are illustrations as well as a definition of each class of machine. Space is also devoted to the special equipment manufactured by the company and a description of the Farrel-Birmingham laboratory facilities, where manufacturers are invited to explore the possibilities of new processing and molding techniques.

If you are concerned in any way with the operation of plastics molding machinery, you will benefit from a copy of this fact-filled bulletin.

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# COMPANIES . . . PEOPLE

**Appointments, promotions, and relocations in the plastics industry.**

**Allied Chemical Corp.—National Aniline Div.: Neal M. Draper** appointed v-p, responsible for sales of organic chemicals, dyestuffs, and pigments. **Max Saltzman** appointed to newly-created post of tech. asst. to v-p, responsible for coordination of R & D projects in connection with pigments. **Harold L. Rieg,** appointed acting resident mgr., Chicago, Ill. branch of the division.

**Hercules Powder Co.: Dr. Gilman S. Hooper** named dir. R & D, fiber development dept., and **Desmond L. Farrell** appointed mgr., polypropylene fiber plant at Covington, Va.

**Monsanto Chemical Co.—Plastics Div.,** Springfield, Mass.: **J. R. Eck** appointed asst. gen. mgr. after serving as pres. of **Mobay Chemical Co.,** jointly-owned by Monsanto and **Farbenfabriken Bayer A.G.,** West Germany. **J. D. Mahoney** elected pres. of **Mobay Chemical Co.** He is succeeded as dir. of marketing by **Howard I. Armstrong. Horace E. Bent** joined the engineering dept.; **Francis T. Goban,** the sales dept.; and **Orville W. Gruebmeyer Jr.,** the pilot plant section of the research dept.

**Union Carbide Corp.—Union-Carbide Plastics Co.: John W. Paterno** appointed tech. rep., New York sales region, responsible for sales for phenolic, epoxy, and vinyl resins.

**Visking Co.: Harry C. Byrne Jr.** named sales mgr., plastic films.

**G. T. Schjeldahl Co.,** Northfield, Minn.: **Noel A. Wright** named sales rep., Dayton, Ohio and Wright-Patterson Air Force Base area. **Dr. Francis H. Bratton** named dir. of research in charge of the company's new mineral fiber program. The company manufactures packaging machinery, industrial tapes and adhesives, air-supported plastic buildings, high altitude research balloons and space Satelloons.

**Food Machinery & Chemical Corp.: Charles F. Ferraro** promoted to supv., polymer evaluation section, organic and polymer dept., at the R & D Center, Princeton, N. J. **Ronald L. DeHoff** joined FMC epoxy dept. as market development rep. for the company's recently introduced Oxiron epoxy resins.

**Dimensional Plastics Corp.** is the new name of **Plastex Laminates Inc.,** 1000 E. 26 St., Hialeah, Fla.

**Pittsburgh Plate Glass Co.—Fiber Glass Div.** established a Boston dist. sales office at 13 Eaton Ct., Wellesley Hills, Mass.: **Thomas M. McLaughlin** appointed dist. sales mgr., **Eugene M. Wheeler Jr.** named sales rep.

**Advance Solvents & Chemical Div., Carlisle Chemical Works Inc.,** New Brunswick, N. J., appointed **Poliquima Industria E Comercio,** Caixa Postal 12745, Sao Paulo, as exclusive agent market and licensee in Brazil. Poliquima will manufacture and market Advastab PVC stabilizers for the plastics industry and Zirco drier catalyst for the paint industry, under a license from Advance Solvents.

**Jones-Dabney Co.—Resins and Chemicals Div.** established three new sales territories for its line of coating resins, including epoxies, vinyls, acrylics, and others: **R. T. O'Connor** named New England rep.; **R. L. Wheeler,** Midwestern rep.; and **G. V. Jenks,** Los Angeles rep.

**J. P. Stevens & Co. Inc.: Richard G. Adams** named head of fibrous glass research, **Central Research Laboratories,** Garfield, N. J. **John S. McBride** joined the Industrial Fiber Glass Dept., New York, N. Y. as asst. to tech. dir., **Richard C. Horton.**

**Girdler Process Equipment Div., Chemetron Corp.,** has moved its headquarters to 2820 W. B'way, Louisville, Ky. The location already houses the div.'s mfg. facilities for Votator continuous processing equipment and Thermex dielectric heating equipment.

**Owens-Corning Fiberglas Corp.** has formed a subsidiary corp., **Owens-Corning Fiberglas International S.A.: George Cook III,** mgr. of the International Div., appointed pres., and **J. Dennis Menton** named sales mgr. The new subsidiary will be responsible for marketing products outside the North American continent.

**California Chemical Co.—Oronite Div.: E. J. Van Buskirk,** formerly N. Y. dist. mgr., surface coatings and plastics chemicals, promoted to newly-created post of resin sales mgr., Los Angeles, Calif. He is succeeded as manager of the New York district by **Vincent Gould.**

**DeSoto Chemical Coatings Inc.,** Chicago, Ill.: **Frank B. Kreider** appointed dir., marketing, for all divs. of the corporation. **Frank J. McLeod** named tech. sales engineer. His activities include market and product development in the reinforced plastics field.

**Barron Plastics Inc.** has moved into its newly constructed building at 100 Barron Dr., Woodlawn, Ohio. Originally distributors of plastic sheet, rod, and tube, the company now has facilities for custom injection molding and fabrication of acrylics, vinyl, and polyethylene.

**Ren Plastics Inc.,** epoxy compounder: **J. Walter Guyer,** dir. of development laboratories, appointed dir. of special projects. The R & D laboratory has been moved from Okemos, Mich. to the firm's general offices and production facilities at Lansing, Mich.

**Louis P. Deis** named mfg. supt. for **AviSun Corp.'s** film and fiber plant in Newcastle, Del.

**Iver G. Freeman** appointed v-p and gen. mgr. **National Cleveland Corp.'s** plastics divs., **Auto-Vac Co.** and **Auto-Blow Corp.** in Fairfield, Conn.

**W. A. Dimler Jr.** appointed sales development engineer, polychemical staff of **Texas Butadiene & Chemical Corp.,** with headquarters in New York.

**Marlow H. Paulson Jr.** named Buton product coordinator for the plastics and resins div. of **Enjay Chemical Co.,** div. of **Humble Oil & Refining Co.**

**John W. Hawley** appointed chief products engineer—thermoplastics, **Molded Products Div., Stauffer Chemical Co.,** Los Angeles, Calif.

**Frank Noonan** joined **Geigy Industrial Chemicals Div.,** customer service dept., Ardsley, N. Y., as product mgr. in charge of fluorescent agents.

**Elwood W. Phares,** formerly sales mgr., promoted to v-p—sales, **Cary Chemicals Inc.,** producer of PVC resins and compounds.

**August Metz** elected pres. of **United Plastics Distributors Assn.** He is gen. mgr., Pittsburgh branch, **Commercial Plastics & Supply Corp.,** New York, N. Y.

### *Corrections*

"Reinforced plastics conference (MPI, Dec. 1960, p. 128): R. C. Harper and F. H. Bratton, who addressed the meeting on "Contour-matched metal molded glass reinforced plastics for outdoor use," are associated with the Cimastra Div. of The Cincinnati Milling Machine Co.

"Tomorrow is today for vinyl—films, sheets, coatings—in construction" (MPI, Dec. 1960, p. 83): Page 84, photo at top of Col. 1 should be credited to Goodyear Tire & Rubber Co. . . . Page 86, Col. 1, Line 30, correct company name is Seal Zit Products Co., Long Beach, Calif. These companies should also be listed in the acknowledgments on page 185.—**End**

# CLASSIFIED ADVERTISEMENTS

**EMPLOYMENT • BUSINESS OPPORTUNITIES • USED OR RESALE EQUIPMENT**

## Machinery and Equipment For Sale

**FOR SALE**—(1) Baldwin 24"x24" platen, 14" ram, 39" dalite, 14" stroke, P. B. cyls. $1800.00. (2) 28"x24" platen size, 14" ram, 34" dalite, 14" stroke, P. B. cyls. $1820.00 ea. Clifton Hyd. Press Co., P.O. Box 325, Clifton, N.J.

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**SHEETER**—Unused, suitable for cutting sheets from rolls up to 57" wide, infinitely adjustable sheet lengths from 2" to 31½". Handles any rigid material to .060. Price $3000. Reply Box 6822, Modern Plastics.

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**TRANSFER MOLDING PRESSES**—300-ton Stokes with Bristol Timers and Dual Pumping Systems. Two available. 100 ton and 80 ton sizes also available. Injection molding machines—8 oz. Reed Prentice, Double Link Type with timers and automatic controls. New 1950's. Several available. Laminating presses—600 ton Adamson with eight 42"x42" steam heated platens—350 ton Universal with twelve 30"x60" steam plates—175 ton Elmes with six 72"x42" steam heated plates. Many other multi-opening presses in stock. We carry a complete line of scrap grinders, extruders, mills, calenders, preheaters, tablet presses, banbury mixers and other equipment for the plastic trade. Liquidations our specialty. What do you have for sale? We will finance your purchases. Johnson Machinery Company, 90 Elizabeth Avenue, Elizabeth, New Jersey, ELizabeth 5-2300.

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**FOR SALE**—(1) Banbury Midget Mixer 2 HP; (1) No. 3 Banbury Mixer 75 HP; (2) Baker Perkins 50 and 100 gal. Sigma Blade Jacketed Mixers; (1) No. 1 Ball & Jewell Rotary Cutter; (1) No. 18 Cumberland Rotary Cutter; (3) Mikro Pulverizers, Bantam, 1SH and 1SI; (6) Stokes Preform Presses, models R, T, DD2, DDS2, DS3 and D4; partial listing, send for details. Brill Equipment Co., 35-55 Jabez St., Newark 5, N.J. Tel: Market 3-7420.

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**FOR SALE**—200 gal. Stainless Jacketed reactors; 1350 gal. T347 Stainless jacketed resin kettle; American 42"x120" dbl. drum dryer, ASME code, Stainless trim; 2750 gal. T316 Stainless pressure tanks, coils, dished heads; Buflovak 42"x120" double drum dryers; 1800 gal. T316SS jacketed and agit. resin kettle; 800 sq. ft. T316SS shell and tube heat exchangers; Baker-Perkins #15-UUMM, 100 gal. jktd. dispersion blade mixer, 100 HP; Buflovak 5'x30' pulverizers; Worthington 70 cu. ft. rotary blender; we pay cash—top dollar—for idle, surplus equipment. Perry, 1429 N. 6th St., Phila. 22, Pa.

**WHEELABRATOR PLASTIC DEFLASHERS** for sale: 20-27 Tumblast, 27x36 Tumblast and No. 1 Multi-table complete with dust collectors, control panels, p.b. stations. Guaranteed to be in like-new condition. Ideal for deflashing of all plastic parts. Universal Machinery & Equipment Co., 1630 N. 9th St., Reading, Pa., FRanklin 3-5103.

**INJECTION MOLDING**—HPM 9 oz; Hydraulic Press, French oil semiautomatic 100 ton; Elmes 60 ton high speed; Mill-Farrell 16x36; Baker Perkins SS, 2 arm, jacketed, vacuum, hydraulic tilt, 100 gal-50HP, also 150 gal-75 HP; Mixer 2 arm 150 gal. Day Imperial steel; Extruder 8" elec. heated; Ram extruder; Machinecraft Corp., 800 Wilson Ave., Newark 5, New Jersey. MI 2-7634.

**SUBSTANTIAL SAVINGS** on good equipment. Unused F-B 14"x30" Two Roll Mills; Good used 2 Roll Mills, 22"x60"; 3 Roll Calender 22"x58" with accessories; 6 Southwark Presses, 36"x36", 14" Ram; Stewart-Bolling Press 36"x36", 22" Ram; HPM Self Cont. Presses, 7 and 25 ton; F-B Unused Belt Press 52" x 31'. Extruders: NRM 1½"; NRM 6" Rubber Tuber; Royle 2" Extruder; Hydraulic Strainer 15". Vulcanizers: 6'x16', 41"x54", 2'x4', others; Utility Rubber Stock Cutter with Conveyor; Baker Perkins 150 gal. Dispersion Mixer, 150 HP; J. H. Day Mogul Mixer, 150 gal. Vac. Cov. 75 HP; Baker Perkins 5 gal. Dispersion Mixer, 30 HP; Banbury #9: J. H. Day 40 gal. Pony Mixers. Inquire about the FMC Rental-Purchase Plan. First Machinery Corp., 209-289 Tenth St., Brooklyn 15, N.Y.—ST 8-4672, Cable "Effemcy."

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**FOR SALE**—(2) 300 ton Dunning & Boschert compression molding presses; (1) Hartig 2" electrically heated plastics extruder; 1 Bipel 35 ton hydraulic preform press; (2) 50, 100 ton self-contained transfer molding presses; (3) Ball & Jewell granulators 15, 10, 7½ horsepower. Chemical & Process Machinery Corp., 52-9th St., Brooklyn 15, N.Y. HY 9-7200.

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**FOR SALE**—DDS-2 Stokes Rotary Preform Machine. Rebuilt and in perfect condition. See operating. Wanted: Defiance Model #20 Preform Machine. Reply Box 6812, Modern Plastics.

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**MOST MODERN PACKAGING AND PROCESSING MACHINERY** Available at great savings. Baker Perkins, W. & P. and Day Double Arm Steam Jacketed Heavy Duty Mixers—25, 50, 75, 100, 150 and 200 gal. capacities. Day, Robinson 50 to 10,000 lbs. Dry Powder Mixers, Jacketed and Unjacketed. Also wood and enamel. H. K. Porter 650 gal. Steam Jacketed Double Spiral mixers. B. P. 100 gal. Jacketed Stationary Vacuum Double Arm Mixer. Day Imperial 75 gal. Double Arm Mixer, Sigma, Dispersion Blades. Mikro Pulverizers, Models Bantam, 1SH, 2TH, 3TH and 4TH. Fitzpatrick Models D, K-7 and K-8 Stainless Steel Comminuters. Colton 2RP, 3RP, 3B, 5½ T Tablet Machines. Stainless Steel Jacketed Mixing Kettles 100 and 150 gal. capacities. Day Ro-Ball Sifters. Package machinery, Hayssen, Scandia, Wrap King, Campbell, Miller Wrappers. Cartoning machines—Ceco, Pneumatic Scale, Jones. Filling machines—all types and sizes. Union Standard Equipment Company, 318 Lafayette Street, New York 12, N.Y. Phone: CAnal 6-5333.

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**FOR SALE**—(5) Circulating air ovens, steam heated. Inside dimensions 10'x11'x6' high. Each fully equipped with 3—6 bladed 30" dia. fans independently driven by 5HP motors, controllers and Minneapolis Honeywell Thermal Recorders 50°—250° F. range. Condition as new. Box 6806, Modern Plastics.

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**FOR SALE**—Baldwin 150 ton, 30"x20" self-contained, Watson-Stillman 240 ton, ten 24"x56" platens. W & W 200 ton, 24"x42". Stokes Standard 50, 100 and 150 ton Semi-Automatic. D & B 150 ton, 25"x25". French Oil 120 ton self-contained. 120 ton Upstroke, 29"x21", 10" stroke. 50 ton Birdsboro 24"x20". Stokes 15 ton automatic Hydraulic Pumps and Accumulators. MPM 3½" wire covering Extruder. New ¾" Plastic Extruder. Other sizes up to 6". Seco 6"x12" and 8"x16", 2-Roll Mills and Calenders and other sizes up to 60". 60" Spreader Heads with XP motors. Despatch electric heated ovens and other types. New ¾ oz. Bench Model Injection molding machines. Van Dorn 1 and 2 oz. Other sizes up to 100 oz. Baker-Perkins and Day Jacketed Mixers. Taylor-Stiles Pelletizer, 7½ HP. Plastic Grinders. Stokes RD4 and R Machines. Send for listings. We buy your surplus machinery. Stein Equipment Company, 107-8th Street, Brooklyn 15, New York.

**FOR SALE**—(1) Model "R" Stokes Preform Press $1,200.00. 2 Leominster Tool Model 5C8 Injection Machines $2,250.00 each. Call or write for appointment to see in operation before removal. R. E. C. Mfg. Corp. 1250 Highland St., Holliston, Mass. GArden 9-2061.

## Machinery Wanted

**WANTED**—Hydraulic Press, laminating type, heating platens, minimum 39"x44". Preferably 6 openings, 100 tons, with pumps and controls. Aligned to produce flat sheets with uniform thickness. Reply Box 6807, Modern Plastics.

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**WANTED**—Used Impco 16 to 22 ounces injection moulding machine. Model VF 822A. Reply to, Bluemel Bros. Ltd., Wolston, Near Coventry, England.

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**WANTED**—66" Vacuum metalizing tank in good condition. Reply to Box 6818, Modern Plastics.

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**PLASTIC PROCESSING** Mach. wanted—60" mill, #9 or 10 Sturdevant blender, Taylor Styles dicer. Lee Chemical Co., 830 Monroe Street, Hoboken, N. J., WH 3-5793 (NYC), OL 6-2020 (NJ).

## Materials Wanted

**GET THE TOP MONEY FOR PLASTIC SCRAP**—Now paying top prices for all thermoplastic scrap. Wanted: polystyrene cellulose, acetate, vinyl, polyethylene, butyrate, acrylic nylon. All types and forms including rejects and obsolete molding powders. Fast action wherever you are located. WRITE, WIRE, TODAY! Reply Box 6828, Modern Plastics.

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**WANTED**—Plastic scrap. Polyethylene, Polystyrene, Acetate, Acrylic, Butyrate, Nylon, Vinyl, George Woloch, Inc., 514 West 24th Street, New York 11, N.Y.

**WANTED—PLASTICS** of all kinds. Virgin, reground, lumps, sheet and reject parts. Highest prices paid for styrene, polyethylene, acetate, nylon, vinyl, etc. We can also supply virgin and reground materials at tremendous savings. Address your inquiries to: Goldmark Plastic Compounds, Inc. 4-05 26 Ave., Long Island City 2, N. Y. RA 1-0880.

**WANTED—WANTED**—Urea and melamine molding powders—distress and surplus supplies wanted. Write Box 6815, Modern Plastics.

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**PLASTIC SCRAP WANTED**—Styrene, polyethylene, butyrate, acetate, vinyl, nylon, etc. Lumps, reground, virgin lots, off grade, molded parts etc. We also have large inventories of virgin and reprocessed materials to offer at realistic prices. Universal Plastics Corporation, 15 Third Street, Passaic, N.J. PRescott 3-0370.

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**PLASTIC SCRAP WANTED**—Acetate, acrylic, butyrate, polyethylene, styrene, vinyl, nylon, etc. We pay top dollar for your plastic scrap and surplus molding powders in any form. We also supply molding powders to the plastic industry at reasonable prices. Please contact for information: Philip Shuman & Sons, Inc., 571 Howard Street, Buffalo 6, New York—tel: TL 3 3111.

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**WANTED** — Large quantities mixed colored flexible vinyl scrap, suitable for sorting. We also need all other grades of thermoplastic scrap materials in the form of regrinds, pellets, rejected parts, etc. Alan Plastics Corporation, Canton, Mass.

*(Continued on page 238)*

# 950 sq. feet of 'Perspex' bring in the business for Pan Am in Piccadilly


This sign, 95 ft. long x 10 ft. deep, was made by Fredk. B. Hall & Co. Ltd., New Cross Road, London, S.E.14, from opal corrugated 'Perspex' acrylic sheet and blue flat sheet 'Perspex' for Pan American World Airways, Piccadilly, London, office.

'Perspex' acrylic sheet as a sign material is one of the world's most efficient business attractions. This efficiency is often best demonstrated by very simple designs like this 95 foot long 10 foot deep fascia sign at the Pan American offices in Piccadilly. Outstanding, crisply readable and yet as distinctive as its surroundings, this is probably the largest illuminated sign ever made from 'Perspex.'

This lightweight, easily shaped material, with a superb finish, is one of the most versatile of the wide range of plastic materials made by I.C.I. If you work with plastics it will pay you to keep in touch with I.C.I., whose job is the developing of new plastics and advising on the application of existing ones.

The I.C.I. Plastics Division technical service is freely available to all customers through oversea companies, agents and representatives.

'PERSPEX'

*'Perspex' is the registered trade mark for the acrylic sheet manufactured by I.C.I.*

**THE FINEST PLASTICS TECHNICAL SERVICE IN THE WORLD**

**Imperial Chemical Industries Ltd., Plastics Division, Export Dept., Bessemer Rd., Welwyn Garden City, Herts., England.**

*U.S.A. Enquiries to: J. B. Henriques Inc., 521 Fifth Avenue, New York 17, N.Y.*

*Canadian Enquiries to: Canadian Industries Limited, Plastics Division, P.O. Box 10, Montreal, P.Q.*

OPS6

(Continued from page 236)

## Materials For Sale

**FOR SALE**—regr. str. & m/c Cycolac Type T—one uniform lot 40,000 lbs.; white rigid vinyl sheet scrap 5,000 lbs.; jet black C/A pellets 15,000 lbs; natural P/E pellets, virg. & repr. 20,000 lbs. Reply Box 6824, Modern Plastics.

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**FOR SALE**—Linear Polyethylene powder natural. Huge quantity exceedingly low price depending on volume. Write Box 6808, Modern Plastics.

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**FOR SALE**—TESLAR 170 lb. 100 gauge type 20 APW duPont Teslar white PVF film. In rolls 21½" wide. Has 6800 adhesive (1) side. Ready to laminate. Value $1050. Make offer. Also 1200 sheets .010 x 21½ x 51½ rigid magnetic vinyl 50% iron oxide. $1000 value, make offer. Reply Box 6831, Modern Plastics.

## Molds For Sale

**PIPE FITTINGS MOLDS**—4 cavity molds for insert couplings and adapters ½", ¾", 1", 1¼", 1½". Excellent condition. Box 6804, Modern Plastics.

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**SOAP DISH MOLD AVAILABLE**—sale or royalty arrangement. New design one-piece dish has been on test sale only, where it met with an excellent reaction. Replaces two-piece polyethylene dish at a lower retail price. Wiggins Plastic Molding Co., Inc., 180 Kingsland Road, Clifton, N.J.

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**FOR SALE**—School supply molds, houseware molds also some novelty and specialty items. All molds in excellent condition. Reasonable prices. List furnished upon request. Sterling Plastics Co., 1140 Commerce Ave., Union, N.J.

## Help Wanted

**PLASTIC PANEL TECHNOLOGIST** is sought by progressive manufacturer. The basic strengths in sales and research of the Butler Manufacturing Company have made its Plastics Department a leader in reinforced plastic panels. To take full advantage of our potential, we are increasing the technical strength of our production staff. We are seeking a man who will be responsible for improving the efficiency of our present panel production—who can relate sales requirements to specifications for new equipment and plant design. In return, we will offer continually increasing responsibility according to your ambitions and performance. A Bachelor's Degree in Chemistry or Chemical Engineering is preferred. We desire also that you have had laboratory work in reinforced plastics, as well as experience in devising and improving production processes. A real asset in this work will be your proved ability to innovate. Your answer, which will be kept in complete confidence, should include a personal resume and be sent to Mr. Orval W. Groves, Employment Supervisor, Butler Manufacturing Company, 7400 East 13th Street, Kansas City 26, Missouri.

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**ARE YOU A PLASTICS SALES PRODUCER?** An attractive sales opportunity exists in our organization where the challenge is formidable but where achievement is readily recognized and rewarded. The man we seek should possess the following qualifications: Minimum two years thermo plastic resin sales experience; Proven outstanding creative sales ability; High degree of intiative and self reliance; Future management potential; Willingness to locate East Coast or Midwest. If you are interested in making the maximum use of your capabilities, please send a summary of your experience and background to: Marketing Manager, Chemicals and Plastics, Cosden Petroleum Corporation, P.O. Box 1311, Big Spring, Texas.

**INJECTION MOLDING SUPERINTENDENT**—Metropolitan New York. Exceptionally interesting connection for a thoroughly expd. man on molding, dies, and machinery. Confidential. Box 168, Realservice, 110 W. 34th St., New York City.

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**PRODUCTION MANAGER** — Ohio molder of reinforced plastics seeks graduate engineer with fundamental knowledge of matched die molding with both preform and premix materials. Previous training and experience must indicate thorough knowledge of the industry. Age 35 to 50. Position offers unusual opportunity for growth. Salary open. A complete resume should accompany your reply to Box 6825, Modern Plastics.

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**PLASTICS CHEMIST**—To handle development program on polyurethane foams and elastomers with fast-growing Southeastern company. Excellent opportunity for growth. Box 6821, Modern Plastics.

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**REVELL, INC.** has a career opportunity for a graduate engineer to function as liaison between the New Products Department and other company divisions. This person will report to the Director of Operations and he will be involved from the inception of a new product until successful production. Some experience in the plastics field and a proven record in project development is required. Send resume to: Revell, Inc., 4223 Glencoe Ave., Venice, California.

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**MOLDING POWDER SALESMEN**—Compounder and distributor of Polystyrene and Polyethylene requires experienced salesmen with following in Eastern and Midwest territories. Salary and commission, five figure earning potential. Box 6819, Modern Plastics.

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**SALESMEN OR SALES TRAINEE**—Plastic manufacturer. Mechanical background plastic exp. helpful. NYC. Salary plus commission. Box MP 1711, 125 W 41 St., N.Y. 36, N.Y.

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**PRODUCT MANAGER** to organize and operate machinery division. Outstanding opportunity for growth in a progressive, fast-growing subsidiary of a Nationally known Chemical Company. Must have sufficient experience to completely supervise the engineering, design and manufacture of forming machinery, dies and take-up equipment for the Plastic Industry. Must also be able to handle selling and advertising program for this equipment. Will be in complete charge of the machinery division. Located 2 hours from New York City in a pleasant resort area community of 5,000. Write giving full details including experience, accomplishments and salary requirement to Box MPL, 1661, 125 West 41 St., New York 36.

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**EXPERIENCED VINYL ROLLER LAMINATING** man to lead new division in old established company, with progressive management. Located in greater Boston area. Excellent salary and unusual opportunity. Our employees know of this ad. All inquiries held in strict confidence. Send replies listing experience, salary requirements and all pertinent information to Box 6830, Modern Plastics.

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**SPRAY ROOM FOREMAN**—Excellent opportunity for man experienced in automatic spray painting of small plastic parts, and familiar with other decorating processes. Plant located in Boston Area. Permanent position with broad company benefits. Reply to Box 6817, Modern Plastics.

**VACUUM METALIZING**—Situation open for man to take complete charge of vacuum metalizing operation in long established firm. Must have complete production and operational knowledge of vacuum plating processes. Plant location in Boston Area. Excellent program of company benefits. Reply submitting resume and salary requirements to: Box 6816, Modern Plastics.

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**PRODUCT DEVELOPMENT ENGINEER**
A leading converter of plastic film and sheeting has position available in its Development Division. Must be an "idea man" for the development of new products drawing from past experience and from laboratory findings of chemical suppliers. Position requires imagination and initiative and good background of experence and chemical education in the PVC industry. Send resume to Box 6814, Modern Plastics.

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**SALES** — PVC Rigid and Semi-rigid sheets. AAA-1 Company expanding into these products, needs experienced man with growth potential to spearhead product development and sales of entire line. Reply Box 6833, Modern Plastics.

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**HELP WANTED**—Injection Molding Foreman, small new plant in New Jersey, old established firm, 5 minutes from George Washington Bridge. Must have 10 years experience. Excellent opportunity. Box No. 6813, Modern Plastics.

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**WANTED—TECHNICAL SALES REPRESENTATIVE** — Manufacturer of Glass Reinforced Alkyd Molding Compounds offers excellent opportunity to aggressive young salesman in New England area. A knowledge of thermosetting molding compounds and molding experience is desirable. Mail resume to GLASKYD Incorporated, Eckel Road, Perrysburg, Ohio; Attention D. K. Welles.

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**PLASTICS APPLICATION ENGINEER**—Development and technical service on new applications of injection molded Delrin, Nylon, Teflon, polypropylene and styrene parts for mechanical applications. Well-known company with new custom-molding affiliate will pay above-average salary to engineer with ability and initiative. Suburban N.Y. location. Reply Box 6812, Modern Plastics.

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**APPLICATIONS ENGINEER**—Degree in Chemical Engineering or Chemistry required. Prefer three year's experience in thermosetting and thermoplastic molding techniques and materials; plus, experience or interest in polyester and epoxy lay-up work, low cost plastic tooling, purchased laminates, and application of thermosetting resins. Work to include engineering development, consultation, in-plant manufacturing applications, and specification writing. Liberal company benefits. Relocation expenses paid. Send resume and salary requirements to Mr. J. F. Caldwell, Dept. 374, Westinghouse-Baltimore, P.O. Box 746, Baltimore 3, Maryland.

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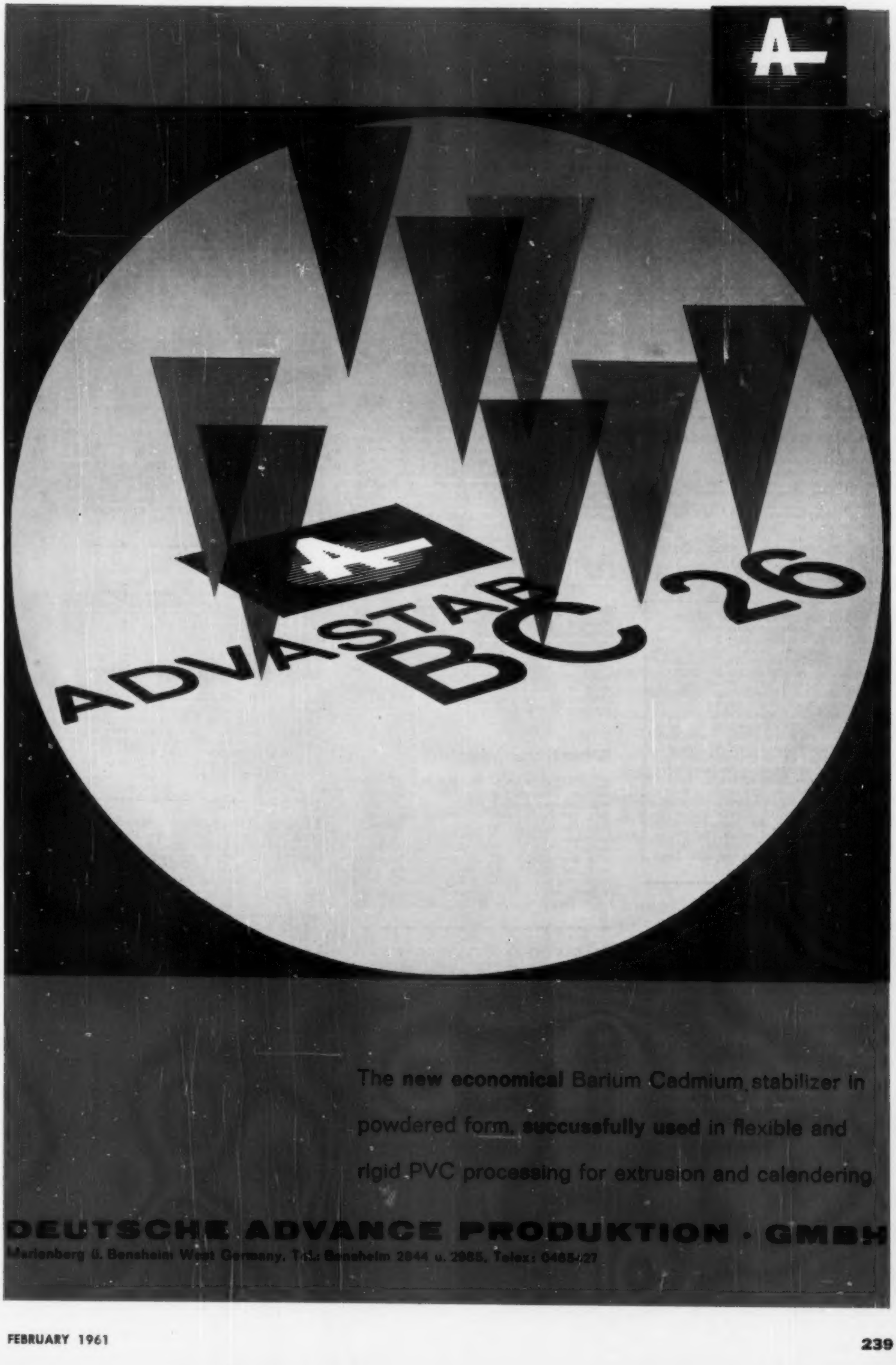
**SALESMAN**—potential sales manager Eastern Division for reprocesser of plastic compounds. Terrific opportunity for experience aggressive individual. Salary open. Chemsol, Incorporated, 74 Dod Street, Elizabeth 3, New Jersey.

(Continued on page 240)


ADVASTAB
BC 26
The new economical Barium Cadmium stabilizer in powdered form, succussfully used in flexible and rigid PVC processing for extrusion and calendering
DEUTSCHE ADVANCE PRODUKTION · GMBH
Marienberg ü. Bensheim West Germany, Tel.: Bensheim 2844 u. 2985, Telex: 0465427

*(Continued from page 238)*

**REPRESENTATIVE** for the sale of injection molding machines and auxiliary equipment wanted in the West, South and Canada. Write to: Acme Machinery, 500 Saw Mill River Road, Yonkers, N. Y.

**NYLON INJECTION MOLDING** Supervisor and set-up man. Fully experienced in mold techniques. For new installation in top rated company located in Rockland County. Excellent opportunity. Please submit resume and salary requirements. Reply Box 6809, Modern Plastics.

**FOREMAN** for reprocesser of plastic compounds. Excellent opportunity for experienced man. Salary commensurate with amount of experience and responsibility man can assume. Chemsol, Incorporated, 74 Dod Street, Elizabeth 3, New Jersey.

**PLASTICS DEVELOPMENT ENGINEER** We have an attractive opening in our New Product Development Dept. for an engineer or chemist to work on fabrication techniques for new thermoplastics. B.S. minimum, 3-10 years broad expreience in fabrication of plastics, especially extrusion. Send resume in confidence to Dr. David M. Clark, Director of Technical Recruiting, W. R. Grace & Co., Research Division, Clarksville, Md.

**PROJECT MANAGER**—The Polymer Corporation. A young progressive and rapidly growing company in the industrial plastics field, located in Reading, Pennsylvania has an excellent position available in its organization for a man with broad ability and training in the engineering field. We require 2—5 years experience in field sales work. Major responsibilities, development of markets for new products, recommending effective marketing methods, customer contact, dissemination of technical data on new developments to field sales personnel. This position offers an excellent opportunity to one who is eager to accept challenge and responsibility. Please address reply, furnishing education, experience and personal data to: Personnel Department, The Polymer Corporation, P.O. Box 422, Reading, Pennsylvania. All replies kept strictly confidential.

**CHEMIST**—Fast growing division of well established company has opening for creative chemist interested in pioneering in the polyurethane and polyester coating field. This position offers challenge in the development of coating compositions for large potential volume applications. At least two years experience in development work, coupled with a B.S. or M.S. degree, is required. Send resume and salary requirements to Mr. A. D. Smith, Personnel Division, Metal & Thermit Corporation, Rahway, N. J.

**MANUFACTURER'S REPRESENTATIVES** wanted by growing and progressive custom molding plant. Open areas in Massachusetts, Northern New England and New York. Desire men with thorough knowledge of plastic molding and small electrical assemblies and capable of offering design suggestions to potential customers. Reply to P.O. Box 359, Wallingford, Conn.

**WANTED**—Man with great experience in polyvinyl chloride resin polymerization, both suspension and emulsion is needed to install and operate polymerization plant, in growing company. Reply Box 6805, Modern Plastics.

**WANTED**—A Plastics Engineer & Mold Designer. Would you like to work with a Canadian company near Detroit? We are looking for a man who will help us develop our United States Plastic Tool and Mold work, who can possibly bring some accounts with him. Write Box 370, Amherstburg, Ontario, Canada.

**SALES ENGINEER** to sell equipment for extrusion, blow molding, injection and compression molding. Engineering degree and three years experience. Salary, profit sharing, expenses, and retirement plan. J. D. Robertson, Inc., Manufacturers' Agents, Suite 404, 3110 Maple Drive, N.E., Atlanta 5, Georgia.

**SUPERVISOR-PROCESS ENGINEERING** Major manufacturer of Industrial Plastics requires a supervisor of process engineering. Applicant must have a broad background in coating and pressing of industrial laminates and be capable of directing the technical and managerial responsibilities of the process engineering function. **PROCESS ENGINEER**—(Mica)—Chemical Engineer or Chemist to assume diversified assignments in the production of mica tapes, sheets, and molded parts. Applicant must be familiar with natural and synthetic resins, molding techniques, and manufacturing processes involving hydraulic presses and treating equipment. Send complete details of experience, background and salary requirements to: Manager-Employee Relations, Continental-Diamond Fibre Corporation, A Subsidiary of The Budd Company, 70 South Chapel St., Newark, Delaware.

**PLASTIC EXTRUSION EXPERT**—We are seeking a development engineer with broad experience and drive to establish and take charge of new plastics fabrication division of large manufacturing company in the metal-working industry. Applicant must have applicable experience in both materials engineering and production techniques. Reply Box 6829, Modern Plastics.

## Situations Wanted

**ENGINEER-MANAGER B.S.M.E.** 17 years design, development, mold engineering, management, reinforced plastics in premix, preform, hand layup and bag molding, filament winding, for boats, aircraft, missiles, chemical process equipment, containers, navigation aids. Comprehensive knowledge of all plastics materials and molding processes, injection, compression, etc. Thorough familiarity with direct, overhead, plant and equipment costs. Reply to Box 6810, Modern Plastics.

**PACKAGING SALES EXECUTIVE.** Energetic, young, creative business builder and successful Sales Manager VP seeks new challenge. Proven ability train sales force into successful team. Outstanding record of "sales delivery." Experienced all phases plastic container fabricating, thermoforming, electronic, heat sealing, contract packaging. Skilled package developer. Wide range contacts with manufacturers nationally known consumer products. University graduate. Reply Box 6811, Modern Plastics.

**WANTED—MANUFACTURERS** of industrial plastic. Distribution wanted of your top quality product, competitive prices, mainly for: Do it yourself, in kits, and Plastic within industrial building. Located in Bergen County, N. J. Reply box 6832, Modern Plastics.

**WESTERN REPRESENTATIVE WANTS**—Additional top quality line for west coast or 10 western states. Present accounts are tooling. From commercial to missile quality. Trades are: plastic molders, Inj., Comp., and blow. Die casters, Aluminum and zinc. Tool and die shops. Precision pattern and model shops working with brass and lucite; castable epoxies, rubber and plasters. Reply Box 6820, Modern Plastics.

**I HAVE WORKED** with plastics from the time plastics started. This amount of experience has paid off. So if you mold pencils, sun glasses, rulers, pens, ball points, etc, aluminum die casting also other metals, this also applies. Finishes of all kinds can be had. Also full patent protection can be had. Write Albert Israelson, Hartington, Nebraska.

**CHEMIST**—With thirty years experience in the formulation and manufacture of synthetic resins and their application as adhesives, paper coatings and molding compounds. Available for consulting and products development work. Reply Box 2826, Modern Plastics.

## Business Opportunities

**SACRIFICE SALE**—Plastics Company presently engaged in vacuum forming, fabricating, model making and engraving services; also has own proprietory items (boats), is being offered at sacrifice figure under $26,000 with or without key personnel. Reply—Amston Plastic Engineering Corp., Amston, Conn.

**PLASTICS BUSINESS WANTED**—We wish to buy an injection molded housewares business. Would also consider molds only. Write in confidence, giving complete details. MONARCH PLASTICS, INC., 4105 Harvard Avenue, Cleveland 5, Ohio.

**FAR EAST**—Experienced, technically trained executive, with strong plastics and chemical industries background, making trip to Japan, Formosa, Hong Kong, Philippines, Singapore, Australia and New Zealand. Free to acept additional commercial or technical assignments. Reply Box No. 2827, Modern Plastics.

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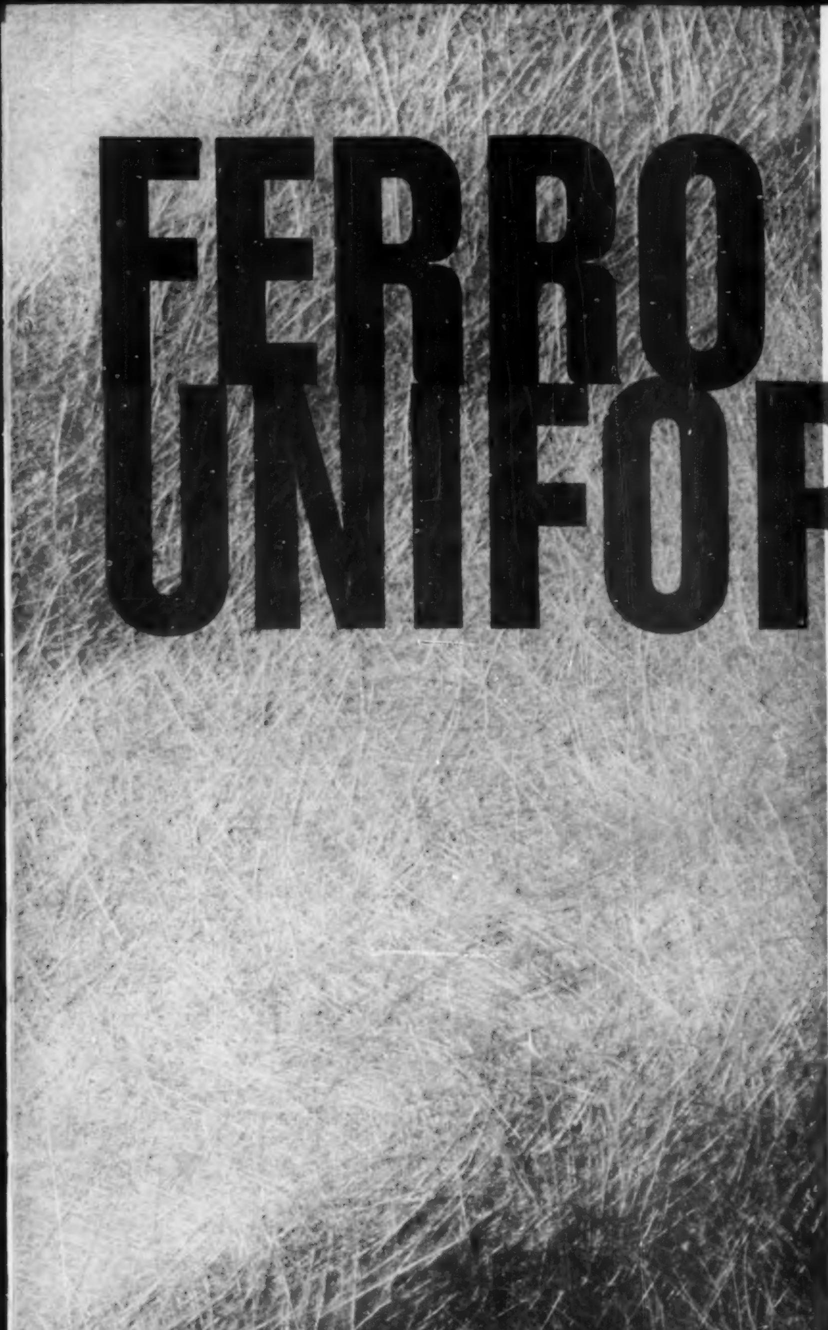

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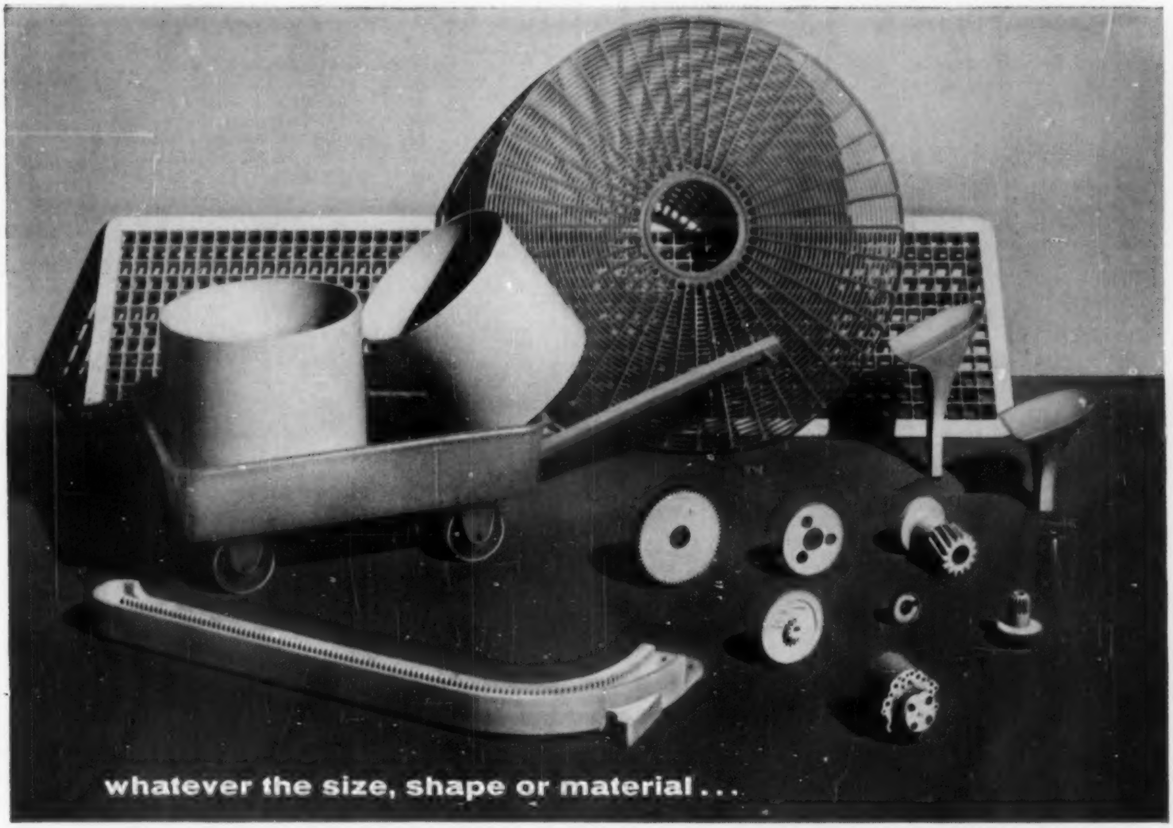


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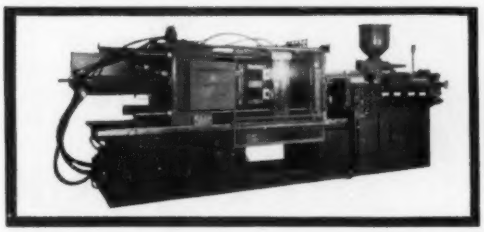

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